

# ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

Edited by

LEWIS STEPHEN PILCHER, M.D., LL.D.  
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With the Association of

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# ANNALS *of* SURGERY

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No. 1

## INTRACRANIAL ARTERIO-VENOUS ANEURISM OR PULSATING EXOPHTHALMOS

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SINCE 1809, when the phenomena of pulsating exophthalmos was first described, until June of 1923, there have been 588 instances of this malady recorded in the literature. This includes the 106 cases up to 1880 collected by Sattler,<sup>1</sup> the 138 cases of the combined series of Keller,<sup>2</sup> 1898, and Reuchlin,<sup>3</sup> 1902, the 69 of de Schweinitz and Holloway,<sup>4</sup> 1907, the 88 cases of the combined series of Bedell,<sup>5</sup> 1915, Rhodes,<sup>6</sup> 1916, Zentmeyer,<sup>7</sup> 1916, and Von Nagy,<sup>8</sup> 1919, and the 131 cases collected by the author.

The purpose of this paper is to gain information concerning the etiology and pathology of pulsating exophthalmos by the analyses of the entire series and especially to study the question of treatment, for thus far the therapeutic results have been quite unsatisfactory. An attempt will also be made to explain the various clinical phenomena associated with this disorder and three cases of the author's own experience will be reported in some detail.

### HISTORICAL

Pulsating exophthalmos was first described in 1809 by Benjamin Travers,<sup>9</sup> demonstrator of Anatomy at Guy's Hospital. He had no post-mortem evidence on which to base his conclusions, but believed the condition was confined entirely to the eye and its etiology was that of "Aneurism by Anastomosis" or cirroid aneurism of the orbit. Travers found that compression of the common carotid artery of his patient caused the bruit to stop and the exophthalmos to decrease and he therefore instituted the surgical treatment of ligation of the common carotid. Thus he was not only the first to describe the condition, but was the first to describe its surgical treatment even in the days before the discovery of anaesthesia. (See Fig. 1, a reproduction of engraving from Travers' original article).

Three years later, in 1812, Dalrymple<sup>10</sup> reported the second case of pulsating exophthalmos and accepted Travers' idea concerning its etiology, and as did the subsequent writers up to 1823. However, in this year, Guthrie<sup>11</sup> performed the first autopsy on one of these cases and instead of finding a cirroid aneurism as had been supposed, he found a nut-size aneurism of the ophthalmic artery and thus he advocated this as the etiology of all previously reported cases of pulsating exophthalmos. In 1837, Warren<sup>12</sup> of Boston reported the first case of pulsating exophthalmos following trauma.

When in 1839, Busk<sup>13</sup> confirmed Guthrie's findings by autopsy of another case, it soon became accepted, at least in England, that aneurism of the ophthalmic artery was the cause of this clinical complex. However, in France in 1835, even four years before

Busk's report, Baron<sup>24</sup> purposed a new etiology, being the first to discover at autopsy a communication between the cavernous sinus and the internal carotid, and thus established the fact that the cause of pulsating exophthalmos might be an intracranial rather than an extracranial disorder. So brief was his report, however, that it escaped general

notice, yet he should have the credit of establishing the most important point in the etiology of pulsating exophthalmos. In 1841, Gendrin<sup>25</sup> reported an autopsy upon a case of pulsating exophthalmos and found as did Baron a communication between the internal carotid and cavernous sinus. Nélaton,<sup>26</sup> in 1856, found another such communication at autopsy, and in 1857, the following year, Hirschfeld,<sup>27</sup> also in France by another autopsy report confirmed the idea of an arterio-venous communication.

Brainard,<sup>28</sup> Professor of Surgery at Rush Medical School, in 1851, cured a case of pulsating exophthalmos by injection of a coagulating fluid into the dilated veins about the orbit, yet the patient lost the vision in that eye. In 1856, digital compression was first recommended and used successfully by Professor Gioppi,<sup>29</sup> of Padua, Italy, for treatment of a case of spontaneous pulsating exophthalmos, and in 1857, bilateral ligation of the carotid was used by Buck,<sup>30</sup> of New York.

In 1870, Delens<sup>31</sup> of Paris, published an exhaustive monograph on arterio-venous communication between the cavernous sinus and the internal carotid. Although French writers after 1835 recognized the intracranial origin of most cases of pulsating exophthalmos, the English continued to attempt to explain the condition on a purely orbital basis. Thus in 1854, Curling,<sup>32</sup> of London, supported the view of Busk concerning the etiology and in 1858, Bowman and Hulke,<sup>33</sup> of London, recorded a case with autopsy in which they found a dilated ophthalmic vein but no intracranial lesion.

In 1859, Nunneley,<sup>34</sup> Chief Surgeon of Leeds Eye and Ear Infirmary, thought the etiology was a false traumatic aneurism of the eye, or less often an aneurism of the ophthalmic artery. Nunneley's next paper in 1864, brought the first admission



FIG. 1.—Engraving of Travers' patient before and after operation, from *Med. Chir. Trans.* 1813, vol. ii. This was the first description of pulsating exophthalmos.

by English authors that the condition might be of intracranial origin. He gave up his former idea of false aneurism and believed that an obstruction to the return flow from the eye through the ophthalmic vein to the cavernous sinus was to be held accountable.



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This obstruction he suggested might be a collection of serum, fibrin, pus, or a tumor. The spontaneous cases he thought were usually aneurisms of the internal carotid or of the ophthalmic artery immediately after its origin.

In 1853, the first case reported which subsided spontaneously without digital compression or ligation was described by France<sup>25</sup> of Guy's Hospital and in 1874, Lansdown,<sup>26</sup> Surgeon at Bristol General Hospital, cured a traumatic case by ligation of the varicose vessels at the inner canthus of the eye, this being the first recorded case cured by an orbital operation.

In 1875, Rivington's,<sup>27</sup> London, notable paper on "Pulsating Tumor of the Orbit"

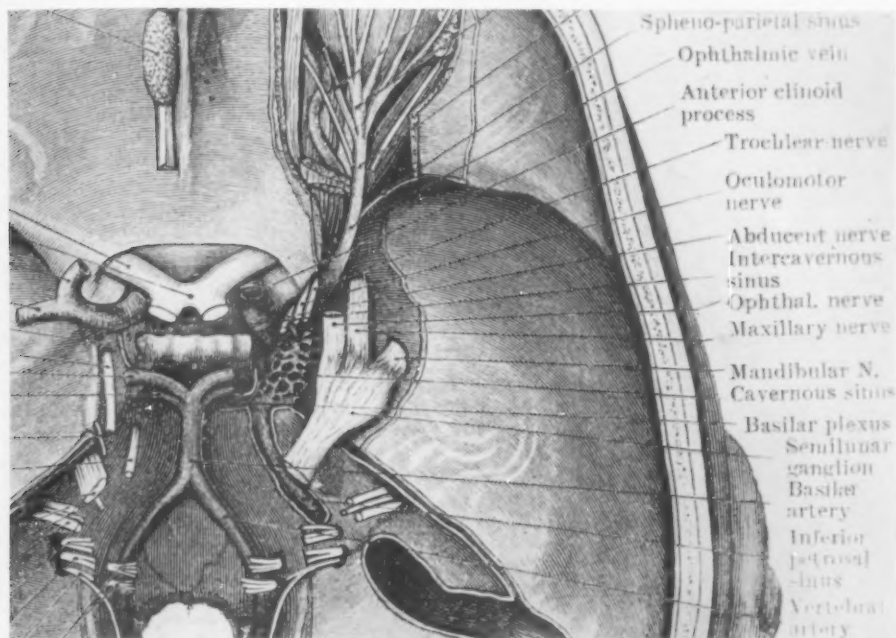


FIG. 2.—The base of the cranium with dura mater undisturbed. Note the relation of the cavernous sinus with the internal carotid artery and with the 2nd, 3rd, 4th 5th and 6th cranial nerves. (From Cunningham's Anatomy, Wm. Wood & Co.)

appeared and was the most comprehensive work on the subject up to that time. Rivington recognized arterio-venous communication as the etiology of most cases, but also mentions aneurism of the ophthalmic artery and morbid conditions of the orbital veins and intracranial sinuses.

Sattler,<sup>1</sup> Berlin, in 1880 collected 106 cases which was a complete list of the reports in the literature up to this date. He too believed that the etiology of most cases was an arterio-venous communication and that in previously reported autopsies this communication had been frequently overlooked.

Similarly, Keller,<sup>2</sup> in 1898, and Reuchlin,<sup>3</sup> in 1902, discussed in inaugural dissertations in Germany the etiology of pulsating exophthalmos and collected additional cases from the literature.

Murray,<sup>28</sup> New York, in 1904 first ligated the internal carotid in treating pulsating exophthalmos and had successful results.

The next large study of the subject was made by de Schweinitz and Holloway,<sup>4</sup> Philadelphia, in 1907. They assembled information from all previously reported cases, making a total of 313 and their figures showed that although a communication between the internal carotid and cavernous sinus was the most frequent cause, yet a certain

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number of cases were due to an aneurism of the ophthalmic or the internal carotid artery, or to tumor of the orbit.

Since this most memorable monograph by de Schweinitz and Holloway numerous

TABLE I.

*Showing Proportion of Males and Females.*

Etiology	Number of cases collected	Number of males	Per cent. males	Number of females	Per cent. females	Sex not stated
<i>Spontaneous</i>						
Author's series (1923) .....	38	6	18.18	27	81.82	5
Combined series of Bedell (1915); Rhodes (1916); Zentmeyer (1916); and Von Nagy (1919) .....	17	6	37.5	10	62.5	1
De Schweinitz and Holloway series (1907) .....	14	6	42.85	8	57.14	0
Combination of all series preceding 1907 including Rivington's, Sattler's, Keller's, Reuchlin's, etc., series .....	57	12	23.64	41	77.35	4
Total spontaneous cases .....	126	30	25.87	86	74.13	10
<i>Traumatic</i>						
Author's series .....	83	60	84.51	11	15.49	12
Combined series of Bedell (1915); Rhodes (1916); Zentmeyer (1916); and Von Nagy (1919) .....	67	56	86.15	9	13.84	2
De Schweinitz and Holloway series (1907) .....	54	31	65.95	16	34.04	7
Combination of all series preceding 1907 .....	214	147	73.5	53	26.5	14
Total traumatic cases .....	418	294	76.76	89	23.24	35
<i>Etiology Not Stated</i>						
Author's series .....	10	6		0		4
Combined series of Bedell (1915); Rhodes (1916); Zentmeyer (1916) and Von Nagy (1919) .....	4	1		0		3
De Schweinitz and Holloway series (1907) ..	1	0		0		1
Combination of all series preceding 1907 .....	29	0		0		29
Total .....	44	7		0		37
Grand total all cases .....	588	331	65.42	175	34.58	82

case reports have appeared, yet no complete assembly of them has been made and hence no conclusions have been drawn.

*Etiology.*— (See Table I.) Of the entire series of 588 cases, there have

# INTRACRANIAL ARTERIO-VEINOS ANEURISM

been 544 cases in which the etiology was stated. Of these, 126, or 23.16 per cent., were spontaneous and 418, or 76.84 per cent., were traumatic in origin. In the series of cases collected by the author the percentage of spontaneous origin was somewhat higher for out of 121 cases in which the etiology was stated, 38, or 31.40 per cent., were spontaneous, and 83, or 68.60 per cent., were traumatic in origin. By reference to Table I, it will be seen that in the spontaneous type the female predominates and in the traumatic type the

TABLE II.  
*Age in Pulsating Exophthalmos.*

<i>Cases of Spontaneous Origin.</i>				
Ages	Author's series	Combined series of Bedell, Rhodes, Zentmeyer and Von Nagy	Series of De Schweinitz and Holloway	Total
1-10	1	0	1	2
11-20	2	2	0	4
21-30	4	3	3	10
31-40	4	0	4	8
41-50	4	3	0	7
51-60	8	2	2	12
61-70	3	1	1	5
71-80	5	3	1	9
81-90	0	1	0	1
Age not stated	7	2	2	11
Total.....	38	17	14	69
<i>Cases of Traumatic Origin</i>				
1-10	0	0	7	7
11-20	18	6	5	29
21-30	16	13	12	41
31-40	13	12	5	30
41-50	9	9	9	27
51-60	5	3	6	14
61-70	1	1	0	2
71-80	0	0	0	0
81-90	0	0	0	0
Age not stated	21	23	10	54
Total.....	83	67	54	204

male predominates. Thus, of the former type we find 74.13 per cent. women and of the latter type 76.76 per cent. men. Of the author's series 81.82 per cent. of the spontaneous cases occurred in women and 84.51 per cent. of the traumatic cases were in men.

As may be seen from Table II, the average age of the spontaneous type is greater than that of the traumatic type. Thus the average age of the spontaneous cases included in this table is near the end of the fifth decade while the average age of the traumatic cases is near the end of the third decade. The average ages in the author's series were forty-eight years for the spontaneous type and thirty-two years for the traumatic.

The left eye is involved more often in the spontaneous type while the right eye is slightly more frequently involved in the traumatic type. The

TABLE III.  
*Showing Proportion of Involvement of Right or Left Eye.*

Etiology	Involving	Author's series	Combined series of Bedell, Rhodes, Zentmeyer and Von Nagy	De Schweinitz and Holloway series	Combined Sattler, Reuchlin and Keller	Totals	Percentages
Spontaneous..	Right Eye	8	8	4	22	42	33.33
	Left Eye	18	4	6	30	58	46.03
	Both Eyes	6	2	2	2	12	9.53
	Not Stated	6	3	2	3	14	11.11
	Total	38	17	14	57	126	
Traumatic....	Right Eye	28	30	25	82	165	39.47
	Left Eye	25	24	21	87	157	37.56
	Both Eyes	14	8	5	31	58	13.88
	Not Stated	16	5	3	14	38	9.09
	Total	83	67	54	214	418	
Etiology not Stated.....	Right Eye	0	1	1	0	2	
	Left Eye	0	0	0	0	—	
	Both Eyes	0	0	0	0	—	
	Not Stated	10	3	0	29	42	
	Total	10	4	1	29	44	

TABLE IV.  
*Table of Autopsy Finding in Pulsating Exophthalmos.*

Lesion	Spontaneous		Traumatic		Total
	Autopsies collected by author	All previous reported autopsies *	Autopsies collected by author	All previous reported autopsies *	
Arterio-venous communication.....	3	7	4	10	24
Thrombosis of cav. sinus and ophth. vein with probable art.-ven. communication.....	0	6	0	2	8
Aneurism of int. carotid.....	1	2	0	1	4
Aneurism of ophth. artery					
Within orbit.....	0	2	0	0	
Outside orbit.....	0	1			3
Tumors of orbit.....	1	6	0	0	7
Lesion not discovered.....	1†	3†	0	0	4
Total.....	6	27	4	13	50

\* Includes 19 autopsies collected by Sattler; 9 by Keller; 2 by Reuchlin; and 11 by De Schweinitz and Holloway.

† Two of these 3 were patients in whom the pulsating exophthalmos had been cured and patients died of other cause.

‡ Incomplete autopsy.



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figures may be seen in Table III. A bilateral pulsating exophthalmos occurs more frequently in the traumatic group than in the spontaneous group.

*Pathology.*—Up to 1907 (de Schweinitz and Holloway), there were 40 autopsies upon cases of pulsating exophthalmos recorded in the literature. Since that time the author has been able to add 10 to this number, making a total of 50 post-mortem examinations. See Table IV. Of this number, 33 were performed upon spontaneous and 17 upon traumatic cases. Of the 33 autopsies on spontaneous cases there were 4 in which no lesion was found.

In two of these, however, the pulsating exophthalmos had been cured some time previous to death and in a third case only an incomplete examination was made. Of the 30 remaining cases there were 16, or 53.33 per cent. in which communication or a probable communication between the internal carotid and cavernous sinus was found, 7, or 23.33 per cent. in which were

tumors, 3, or 10 per cent. aneurisms of the internal carotid, 3, or 10 per cent. in which aneurism of the ophthalmic artery was revealed, and 1, or 3.34 per cent. in which no lesion was found. The findings of 17 autopsies upon traumatic cases is quite a different story, for 16, or 94.12 per cent. of these proved to be arterio-venous communication of the internal carotid and cavernous sinus, and only one case as aneurism of the internal carotid.

Although arteriosclerosis has been a prominent feature in many of the spontaneous type there are very few cases in which the history suggests lues. There have been, since the time of the Bordet-Wassermann reaction, 19 cases on which this test was performed. Of this number 2 were positive and 17 negative. One of the cases with a positive reaction was a thirteen year old lad having a traumatic type and the other was a woman of seventy-eight years with a spontaneous type in which autopsy showed a tumor of the orbit. From the evidence available we would therefore conclude that lues is not a contributing factor.

In summarizing the pathology it may be stated from the scant information at hand that practically all cases of the traumatic type of pulsating exophthalmos are due to an intracranial arterio-venous communication. Of the spontaneous type only a little over one-half of the cases can be attributed to this cause, while about one-quarter are caused by tumor and another quarter by simple aneurism of either the internal carotid or ophthalmic artery.

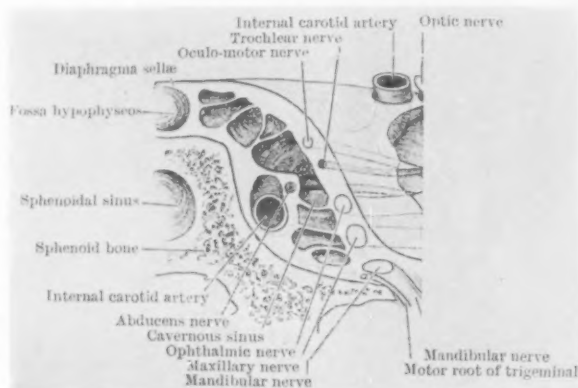


FIG. 3.—Cross-section showing internal carotid within the cavernous sinus and the proximity of the 3rd, 4th, 5th and 6th cranial nerves. (From Cunningham's Anatomy, Wm. Wood & Co., Publishers, 51-5th Avenue, New York, N. Y.)

*Anatomical Considerations.*—The anatomical boundaries of the cavernous sinus and the close relation to the internal carotid are clearly shown in Fig. 2 from Cunningham's Anatomy. The proximity of the 2nd, 3rd, 4th, and 6th cranial nerves, and ophthalmic division of the 5th cranial nerve to the cavernous sinus may be readily seen. A cross-section of the cavernous sinus, Fig. 3 from Grey's Anatomy, shows the internal carotid artery

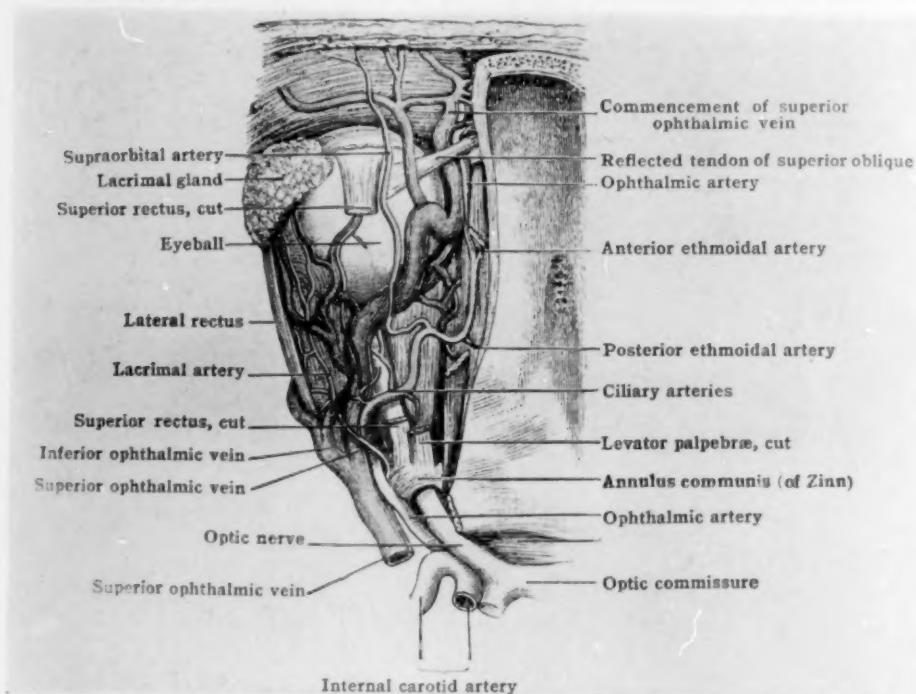


FIG. 4.—The left ophthalmic artery and vein. Note the venous plexus behind the orbit. Exophthalmos associated with intracranial arterio-venous fistula of the internal carotid and cavernous sinus may be caused by the dilatation of these pulsating vessels pushing the eye forward. (Morris' Anatomy, P. Blakiston's Son & Co.)

lying within the sinus with the 3rd, 4th, 6th and the ophthalmic and maxillary divisions of the 5th cranial nerve.

Rawlings<sup>20</sup> has found that 70 per cent. of the fractures of the base of the skull involve the body of the sphenoid bone. Both internal carotid artery and cavernous sinus are comparatively immovable in this region so that it is quite natural that an underlying fracture might rupture or injure their adjacent walls. The cases of actual rupture are those clinically in which the patients hear the bruit immediately upon return of consciousness, while those who hear the bruit only some days or weeks after the accident are cases in which only a damage of the vessel walls has occurred, which later ruptures. A penetrating wound, too, may have such a course that it comes in contact intracranially with both internal carotid artery and cavernous sinus. It thus may rupture or weaken the adjoining walls of these two vessels.

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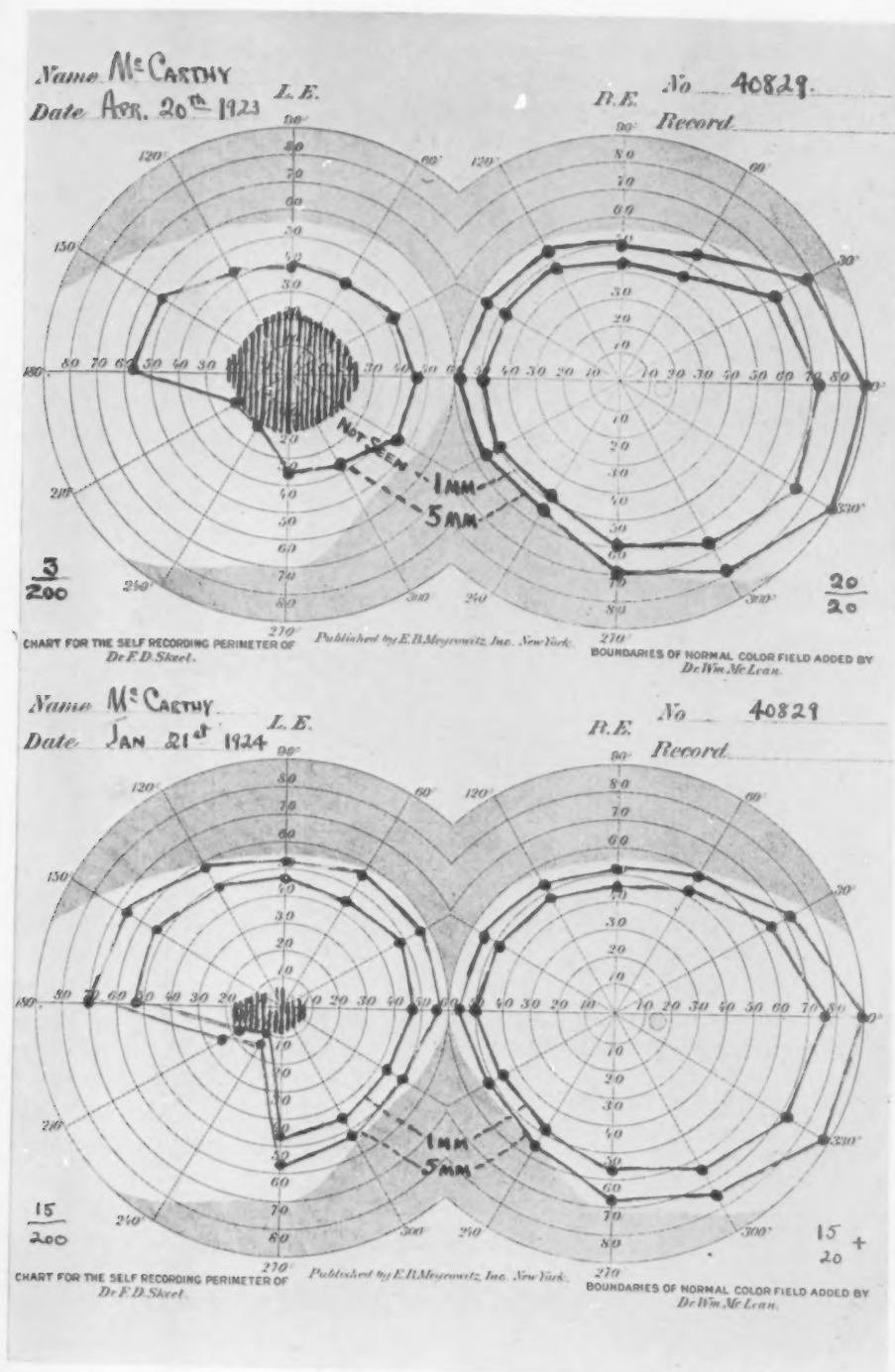


Fig. 5.—Chart of visual fields of Case I before and after operation. Note the decrease in size of the central scotoma. (By courtesy of E. B. Meyerowitz Surgical Instrument Co.)

The mechanism of production of a pulsating exophthalmos spontaneously without an injury is more difficult to explain. This may be due to a diseased and weakened condition of the walls of the adjoining vessels. Again, it seems probable that an arterio-venous communication may occur by a rupture of a simple aneurism in the portion of the internal carotid which lies within the cavernous sinus or in its immediate neighborhood. The



FIG. 6.—Case I before operation. Note the exophthalmos and internal strabismus of left eye and the ptosis of left upper lid infringing on pupil.

spontaneous type of pulsating exophthalmos, of course, may be due also to a simple aneurism of the internal carotid or ophthalmic artery, or even to tumor of the orbit.

The enormously dilated and pulsating ophthalmic vein lying behind the orbit affords at least one explanation of the exophthalmos and orbital pulsation associated with the phenomena of arterio-venous communication between the internal carotid and cavernous sinus. Figure 4 of the orbital veins after Poirier and Charpy show the plexus behind the orbit, which takes part in this dilatation.

The explanation of the cause of the very large, pulsating, vascular masses above the internal angle of the eye is a question which naturally arises. One would suspect with a fistula between the internal carotid

and the cavernous sinus that the rush of arterial blood would be amply taken care of in the great intracranial venous sinuses. This, however, is not true, for in the majority of cases much of the arterial blood finds its way into the superior ophthalmic vein forming large dilated swellings. The anatomical explanation of this fact, I think, is that the ophthalmic veins have no dense tissues surrounding them such as the bone and dura which surround the superior and inferior petrosal sinus, the other exists of the cavernous sinus.

The various cranial nerves may be involved in four very different ways by four very different types of mechanism: First, that of direct injury of the nerve by the fracture or contusion which causes the rupture of the cavernous sinus and internal carotid. Thus the 1st, 2nd, 3rd, 4th, 5th, and 6th



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cranial nerves are often taken and less frequently the 7th and 8th. These signs are present soon after injury and perhaps are augmented by slow hemorrhage. The visual fields of Case I shown in Fig. 5 are an example of this type of injury. Secondly, cranial nerve signs may be caused by pressure from actual dilatation and hypertrophy of the vessels on either side of the arterio-venous communication. The cranial nerves affected by this mechanism are the 2nd, 3rd, 4th, 6th and the ophthalmic division of the 5th, and the signs usually appear some days or weeks after the injury. The effect of a third type of mechanism is limited to but one cranial nerve. It is due to pressure upon the supraorbital nerve near its exit from the supra-orbital foramen by the enormous pulsating dilations of the superior ophthalmic vein and its branches. Thus in the author's second case it seemed probable that this was the mechanism for the slightest touch with the finger in the region of the supraorbital foramen would often cause sharp and uncomfortable paræsthesias over the left frontal region. The fourth mechanism is limited to the 2nd nerve and is of purely circulatory nature. Thus it seems that the short circuiting of arterial supply or even venous congestion may cause optic trophy.



[FIG. 7.—Case I two weeks following ligation of left internal carotid. Note improvement in the exophthalmos, the ptosis and the internal strabismus.]

*Symptoms and Signs.*—The following case reports illustrate the subjective and objective findings in this rare condition of pulsating exophthalmos. Cases I and II are from the division of neurosurgery of the University of California Hospital, Case III a San Francisco Hospital patient which the former Resident Surgeon, Dr. Ray Kistler, was good enough to send to us for examination. A fourth case will be merely mentioned which was a patient at the Peter Bent Brigham Hospital on Doctor Cushing's wards, that came under my care during my service as Neurosurgical Resident.

*CASE I.—Accident. Resulting Pulsating Exophthalmos. Digital Compression of Carotid No Improvement. Ligation of Internal Carotid. Marked Improvement.*

University of California Hospital No. 18043, an American male, aet, twenty-five, an electrician by occupation had a negative family history except that father died aet, forty-six of apoplexy. Past history was negative. Present illness: On September 25, 1922, the patient was in an automobile accident and was unconscious for forty-eight hours, with profuse bleeding from the right ear, nose and mouth. There was no subsequent memory of the next five days, but on fully regaining his senses, he noticed numbness of the left side of the face, stopping at the midline, deafness of right ear, and with the left eye his vision was only sufficient to distinguish between light and darkness. Six weeks after accident, the patient was first aware of a blowing bruit within his head, louder on the left side, which he described as sounding like "the exhaust of a steam valve". At this time the vision in the left eye was still defective and soon

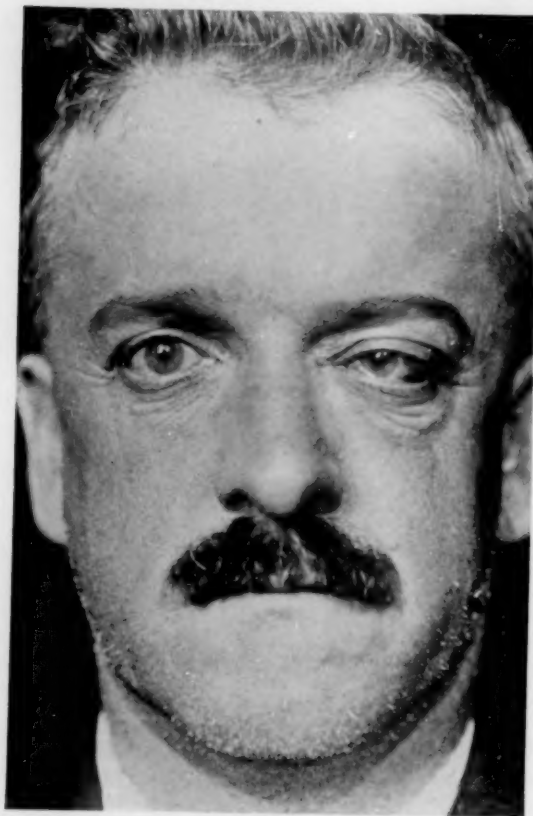


FIG. 8.—Case II before operation. Note exophthalmos, internal strabismus and ptosis.

an internal strabismus and exophthalmos of O.S. appeared. He then first noticed a bilateral loss of smell. On January 4, 1922, the patient entered University of California Hospital. At this time physical and neurological examination showed a well developed, very muscular young man with a left-sided pulsating exophthalmos (see Fig. 6), a systolic blowing bruit best heard over left eye and left temporal region, and an external rectus palsy of O. S. with internal strabismus. There was some engorgement of the small veins at the inner canthus and of the upper lid, but without distinct pulsation of them. The left pupil reacted sluggishly and there was marked ptosis on this side. Although definite subjective symptoms of numbness over the 1st and 2nd divisions of the left trigeminal were present, there were no objective signs. Hearing was diminished in the right ear, there was a bilateral loss of olfactory sense and visual acuity of O. S. was such that patient could see only the 20/100 letters when holding an ordinary acuity chart in his hand; acuity of O. D. was 20/20. Ophthalmoscopic

examination of O. S. showed a pale disc with slightly hazy outline and dilated tortuous veins; O. D. normal. Visual fields showed defect (see Fig. 5), an X-ray of skull showed a left frontal fracture. Blood-pressure was 128/95. Compression of the left common carotid stopped the bruit subjectively and objectively while compression of the temporal or facial arteries or the carotid on the opposite side had no effect. Blood Wassermann and urine were negative. *Treatment:* For about three weeks the patient was kept quiet in the hospital and digital compression applied. Due to the heavy musculature of his neck, compression could not be maintained for over 10 to 15 minutes at a time. Even a slight movement of the sterno-mastoid muscle or the act of swallowing would cause the artery to slip away from the compressing finger. The patient was then sent home where the same treatment was continued for

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eleven weeks without improvement. On May 1, under local anaesthesia the left internal carotid was exposed and compressed with a Crile clamp for thirty minutes. During this time no weakness, nor numbness of the opposite extremity developed, so a permanent double ligature was made. This shut off the bruit subjectively, but objectively it was still present, yet diminished to about one-tenth of its previous intensity and was of a very much higher pitch. During the following weeks the bruit became even more feeble and often could not be heard at all. It could be entirely shut off by compression of the opposite carotid. The exophthalmos improved remarkably, the internal strabismus largely disappeared and ptosis became less marked (see Fig. 7). The patient went back to work July 1, 1923, and reported that he had been working steadily when seen again on January 21, 1924.

At this date his appearance was the same as that shown in Fig. 7. Visual fields showed same defect in O. S. as that noted before operation. The central scotoma, however, had decreased in size and usual acuity was somewhat improved (see Fig. 5). Nevertheless, examination of the fundus O. S. showed increased pallor of the disc with increased distinctness of the cribriform markings. The blood-vessels appear normal. A faint bruit, barely audible, was heard over the left orbit and in the left temporal region. This is, however, not heard by the patient except occasionally at night. The defect in olfactory sense was still evident although not as well marked as previously. Auditory acuity on the affected side, the right side, was almost normal.

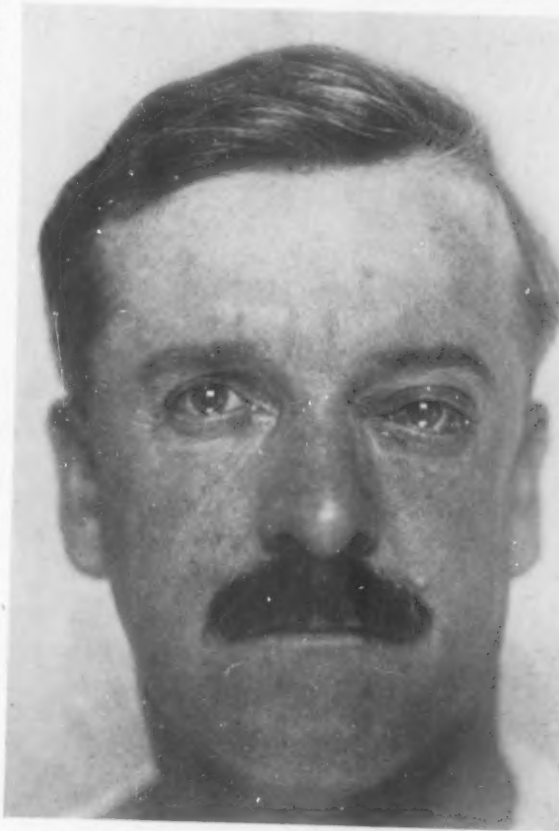


FIG. 9.—Case II two weeks after ligation of left internal carotid. Note improvement in exophthalmos, strabismus and ptosis.

CASE II.—*Accident. Pulsating Exophthalmos. Digital Compression of Carotid. No Improvement. Ligation of Internal Carotid. Improvement. Ligation of Superior Ophthalmic Vein. Further Improvement.* University of California, Hospital No. 19647-A an Irish born American male, aet. forty-two, a drygoods clerk by occupation, had an insignificant family history. Past history was negative except for malaria aet thirty-five; Neisser aet eighteen; and excessive use of alcohol and tobacco. Present illness: On September 25, 1922, while intoxicated, was struck by a motor truck, was unconscious for one and one-half hours and had considerable bleeding from his nose, although for the next forty-eight hours the patient seemed conscious, he had no subsequent memory of this time. He first remembered severe left frontal and partial headaches and a blowing noise within his head. Five days after accident there was diplopia and the left eye turned inward but exophthalmos was not noted until about five weeks later. About four months after accident he first was aware of paræsthesias over ophthalmic division of the left trigeminal

nerve and he entered the University Hospital, February 6, 1923, almost four and one-half months after injury. At this date physical examination and neurological examination showed a well marked pulsating exophthalmos O. S. (see Fig. 8), a systolic bruit heard loudest over O. S.; marked dilatation of angular and naso-frontal veins and also the veins of the upper lid and tiny vessels of the conjunctivum. A distinct thrill could be felt near the internal canthus. Almost a complete 6th nerve palsy with internal strabismus was present. Very slight pressure in the supraorbital region gave paresthesias over ophthalmic division of 5th nerve, yet in this region no actual sensory changes were demonstrable, and the corneal reflex was present. Fundi showed dilated



FIG. 10.—Case II six months following ligation of dilated veins of the supraorbital region.

and tortuous retinal veins but no atrophy nor oedema. Compression of the left common carotid caused the bruit to cease, but after ten minutes of compression, numbness of right arm and leg appeared. Compression of opposite carotid, left facial or temporal arteries had no effect, yet compression of the dilated veins at the inner canthus of O. S. caused the bruit to cease almost entirely. Visual fields showed no defect and X-rays of skull were negative. Blood Wassermann and urine were negative. Blood pressure was 116/76. *Treatment:* Because of the numbness of right extremities resulting from shutting off of the left carotid, preliminary graded digital compression was employed. At first ten-minute periods of compression three times a day were used and during six weeks the periods gradually increased to one hour, three or four times a day. Numbness of opposite extremity no longer resulted. The exoph-

thalmos and bruit, however, became worse. On May 26, 1923, under local anaesthesia, the left internal carotid was exposed and compressed with a Crile clamp for sixty minutes. During this period no numbness, anaesthesia nor paresis appeared on the opposite side, and the bruit was entirely shut off. A permanent double ligature was then made. This continued to shut off the bruit subjectively and objectively and during the next two weeks exophthalmos decreased to about one-half, the pulsation was hardly visible, and the 6th nerve palsy largely disappeared (see Fig. 9). The bruit was not audible to the patient, but after two weeks it could be very readily heard by the stethoscope over the mass of dilated and pulsating veins above the inner canthus. This mass increased in size and a more distinct thrill than ever could be felt over it. On July 16, 1923, under local anaesthesia the left supraorbital and supranasal region was explored. The angular and naso-frontal veins were found to be dilated to the size of a little finger and these were doubly ligated and cut as they branched from the superior ophthalmic vein. For the following few days there was congestion about the eye and



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exophthalmos was more marked than before. Then the exophthalmos subsided and it was found that the pulsating swelling was entirely gone from the internal angle of the orbital fossa. The objective bruit, too, had disappeared, there were no signs of ocular palsies and pupil reacted normally. Some exophthalmos remained. (See Fig. 10). On January 21, 1924, the patient appeared as shown in Fig. 11. His exophthalmos had not altered during the last few months and he hears a bruit only occasionally at night while in bed. There has been, however, some increase in the size of the superficial veins of the left temporal region and of the upper lid of O. S.

CASE III.—*Accident. Resulting Pulsating Exophthalmos. Rest, Morphine, Codein and Digital Compression, Cure.* San Francisco Hospital No. 50391, a German male, aet. sixty-seven and a painter by occupation had a negative family history and past history. Present illness: On January 9, 1921, the patient was struck by a street car, was unconscious for one hour and had no subsequent memory of events occurring until eight hours after the accident. Then he noticed a severe headache. He was taken to the San Francisco Hospital. Examination showed a well developed and nourished middle-aged man in a stuporous condition. There were marked ecchymoses about each orbit and X-ray of the skull showed a left frontal fracture. No cranial nerve palsies were present. Thirteen days after the accident a paresis of the internal rectus muscle O. S. appeared and four days later there was an almost complete ophthalmoplegia externa O. S. and immobile pupil. Two weeks later, or one month after accident, a pulsating exophthalmos O. S. appeared. (See Fig. 12.) About this time subjectively as well as objectively, a blowing bruit could be heard. It was almost continuous but accentuated during systole. Exophthalmos increased and there was marked chemosis. Compression of the left common carotid shut off this bruit and sometimes it would disappear of its own accord for a time. Visual fields revealed no defect but acuity was down to 20/200 in O. S. while 20/20 in O. D. Examination of fundi showed engorgement of veins and a slightly hazy disc. Urine negative; blood-pressure not elevated. *Treatment:* Simple means such as rest, morphine, codein and digital compression of the common carotid were used. Ligation of the carotid was considered but the patient seemed to be improving so rapidly that it was not done. Two weeks after the appearance of the pulsating exophthalmos it had started to subside. In five weeks more the bruit and the ocular palsy had entirely disappeared and the exophthalmos was almost entirely gone. In another month's time there was no exophthalmos and visual acuity of O. S. was 20/70. At present no exophthalmos is present (see Fig. 12), and there are no ocular palsies. Visual acuity is O. S. now only 5/200 for a cataract has developed. The disc is somewhat pale and the arteries are much smaller than on the opposite side. Visual fields are normal. From external examination of the eyes the only abnormalities to be noted are



FIG. 11.—Case III one month after accident.

slight puffiness under the eye and scleral and episcleral vessels which are larger than those of the opposite globe.

CASE IV.—This case will be merely mentioned as a preliminary report\* has already been made by Doctor Yoakum and the complete report will appear elsewhere.

It was a case of traumatic pulsating exophthalmos following a gunshot wound of the head. Infection of the wound followed an exploratory operation in the region of the angle of the jaw, near the entrance of the bullet. After this the pulsating exophthalmos decreased, and now, three and one-half years later, the patient is perfectly well except for a slight abducens weakness.



FIG. 12.—Case III two and one-half years after accident.

*Diagnosis.*—The clinical phenomena of pulsating exophthalmos is easily recognized yet the decision whether the underlying pathology is an arterio-venous communication, a tumor of the orbit, or an aneurism of the internal carotid or ophthalmic artery, is often difficult.

The age of the patient is of some importance in the decision, for aneurismal types are more apt to occur in middle-aged or elderly people. An aneurismal type may, however, become an arterio-venous communicating type by the rupture of a single aneurism of the internal carotid artery lying within the cavernous sinus. The traumatic cases are nearly always actual arterio-venous communication. The presence of a pulsating

swelling above the inner canthus also usually means an arterio-venous type, and bruit is usually louder than with simple aneurism or with tumor. Exophthalmos is greater with tumor and the communicating type than with the aneurismal type.

With orbital tumor de Schweinitz states that the pulsating exophthalmos develops very slowly. The orbital growth, too, may often be palpable and efforts to reduce the exophthalmos are encountered with more resistance than in the other types. The bruit if present at all is very feeble.

Other conditions such as a destructive process of the roof of the orbital

\* See proceeding of the Boston Society of Psychiatry and Neurology meeting at Peter Bent Brigham Hospital, January 20, 1921. Arch. Neur. and Psych., June, 1921, vol. v, p. 754.

fossa or as an orbital encephalocele may cause pulsating exophthalmos, but here no bruit is present.

*Treatment.*—The treatment of this condition consists of the various therapeutic procedures which tend to prevent the direct short circuiting of arterial blood into the venous system. The three very different principles that have been applied for this purpose are the following:

(1) The production of stasis or obstruction of the blood in the arteries afferent to the arterio-venous fistula, such as compression or ligation of the carotid artery.

(2) The production of stasis or obstruction to the arterial blood in the veins afferent from the arterio-venous communication, by means such as ligation or compression of superior ophthalmic vein.

(3) Methods aimed at the promotion of clot formation in both arteries and veins such as subcutaneous gelatin injections or simple rest.

The following results have been obtained by the various different methods. (See Table V.)

*Digital Compression.*—Certainly has its place as a curative therapy, as well as a preparatory procedure for carotid ligation. Since de Schweinitz and Holloway's monograph in 1907 there have been 27 cases treated in this manner with 11 patients, or 37.04 per cent. cured or improved. For the complete series of 106 cases treated by digital compression the results are less striking as there were just 26.41 per cent. cured or improved. However, by comparing the results of digital compression with those of the more radical procedures (see Table V) the reader will probably agree with the author's conclusion that this form of treatment should be thoroughly tried out as the initial therapy. It has been more effective in the treatment of spontaneous cases than those of the traumatic type.

*Ligation of the common carotid* was the treatment employed by Travers upon his case, the first one in the literature and this was in 1805, before the days of anæsthesia. In the literature since the publication of de Schweinitz and Holloway's monograph in 1907 there have been 84 patients



FIG. 13.—Instrument employed to compress the common carotid artery against the transverse processes of the cervical vertebræ. The wooden frame is placed in position about the neck and the rubber cross-piece is then stretched to fasten over the screw-A.

TABLE V.  
*Results of Treatment of Pulsating Exophthalmos.*

Treatment	1923—1907			1907—1809			1923—1809	
	Series (1) Author's series	Series (2) Bedell, Rhodes, Zentmeyer, Von Nagy	Series (1) & (2) Result percentages	Series (3) De Schweinitz and Holloway	Series (4) Sattler, Renschlin, Keller	Series (3) & (4) Result percentages	Totals	Result percentages
Digital compression.....	Total.....23 Cured.....3 Improved.....7 Negative.....13 Fatality.....0 Not stated...0	Total.....4 .....0 .....0 .....0 .....0	11.11 25.93 62.96 0.0 0.0	Total.....11 Cured.....3 Improved.....8 Negative.....0 Fatality.....0 Not stated...0	Total...68 15 53 0 0	24.05 75.95 0.0 0.0	Total...106 28 78 0 0	26.41 73.59 0.0 0.0
Ligation of common carotid	Total.....50 Cured.....16 Improved.....15 Negative.....11 Fatality.....5 Not stated...3	Total.....34 14 12 7 1 0	35.72 32.14 21.43 7.14 3.57	Total.....34 Cured.....17 Improved.....13 Negative.....4 Fatality.....0 Not stated...0	Total...116 80 25 11 0	64.60 25.30 10.00 0.0	Total...234 154 56 21 3	65.81 23.93 8.98 1.28
Ligation of internal carotid	Total.....25 Cured.....6 Improved.....15 Negative.....1 Fatality.....3	Total....7 1 6 0 0	21.87 65.64 3.12 9.37	Total.....6 Cured.....1 Improved.....4 Negative.....1 Fatality.....0		16.66 66.66 16.66 0.0	Total...38 8 25 2 3	21.05 65.79 5.26 7.90
Bilateral ligation of carotids	Total.....9 Cured.....0 Improved.....6 Negative.....2 Fatality.....1 Not stated...0	Total....2 0 1 0 0 1	0.0 63.64 18.18 9.09 9.09	Total.....1 Cured.....0 Improved.....0 Negative.....1 Fatality.....0 Not stated...0	Total...9 6 2 1 0	60.00 20.00 20.00 0.0	Total...21 13 4 3 1	61.91 19.05 14.28 4.76



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Ligation of orbital veins alone.....	Total..... 8 Cured..... 2 Improved..... 2 Negative..... 3 Fatality..... 1	Total..... 6 Cured..... 3 Improved..... 1 Negative..... 2 Fatality..... 0	35.72 35.72 21.43 7.14	Total..... 3 Cured..... 1 Improved..... 2 Negative..... 0 Fatality..... 0	Total... 2 Cured..... 2 Improved..... 0 Negative..... 0 Fatality..... 0	60.00 40.00 0.0 0.0	Total... 19 Cured..... 8 Improved..... 5 Negative..... 5 Fatality..... 1	42.12 26.31 26.31 5.26
Ligation of carotid and orbital veins.....	Total..... 10 Cured..... 3 Improved..... 1 Negative..... 2 Fatality..... 4	Total..... 5 Cured..... 0 Improved..... 4 Negative..... 1 Fatality..... 0	20.00 33.33 20.00 26.67	Total..... 1 Cured..... 1 Improved..... 0 Negative..... 0 Fatality..... 0	Total... 5 Cured..... 3 Improved..... 2 Negative..... 0 Fatality..... 0	66.66 33.33 0.0 0.0	Total... 24 Cured..... 9 Improved..... 8 Negative..... 3 Fatality..... 4	37.50 33.33 12.50 16.67
Rest and medication.....	Total..... 18 Cured..... 2 Improved..... 5 Negative..... 9 Fatality..... 1 Not stated... 1	Total..... 4 Cured..... 1 Improved..... 2 Negative..... 1 Fatality..... 0 Not stated... 0	13.64 31.82 45.45 4.54 4.54	Total..... 6 Cured..... 1 Improved..... 3 Negative..... 2 Fatality..... 0 Not stated... 0	Total... 0 Cured..... 0 Improved..... 0 Negative..... 0 Fatality..... 0 Not stated... 0	16.66 50.00 33.33 0.0 0.0	Total... 28 Cured..... 4 Improved..... 10 Negative..... 12 Fatality..... 1 Not stated... 1	14.29 35.72 42.85 3.57 3.57
Gelatin injections.....	Total..... 6 Cured..... 1 Improved..... 3 Negative..... 2 Fatality..... 0 Not stated... 0	Total..... 7 Cured..... 3 Improved..... 2 Negative..... 2 Fatality..... 0 Not stated... 0	30.78 38.46 30.76 0.0 0.0	Total..... 3 Cured..... 1 Improved..... 0 Negative..... 2 Fatality..... 0 Not stated... 0	Total... 0 Cured..... 0 Improved..... 0 Negative..... 0 Fatality..... 0 Not stated... 0	33.33 0.0 66.66 0.0 0.0	Total... 16 Cured..... 5 Improved..... 5 Negative..... 6 Fatality..... 0 Not stated... 0	31.25 31.25 37.50 0.0 0.0

treated in this manner. Of these, there were 67.86 per cent. cured or improved, with a mortality of 7.14 per cent. (See Table V). The earlier series from 1809 to 1907 shows a slightly higher mortality of 10 per cent., possibly due to the septic operative wounds which occurred frequently before Lord Lister's discovery in England and Pasteur's introduction of the aseptic operating room at "Hôpital Cochin", Paris.

*Ligation of the Internal Carotid.*—for pulsating exophthalmos was first

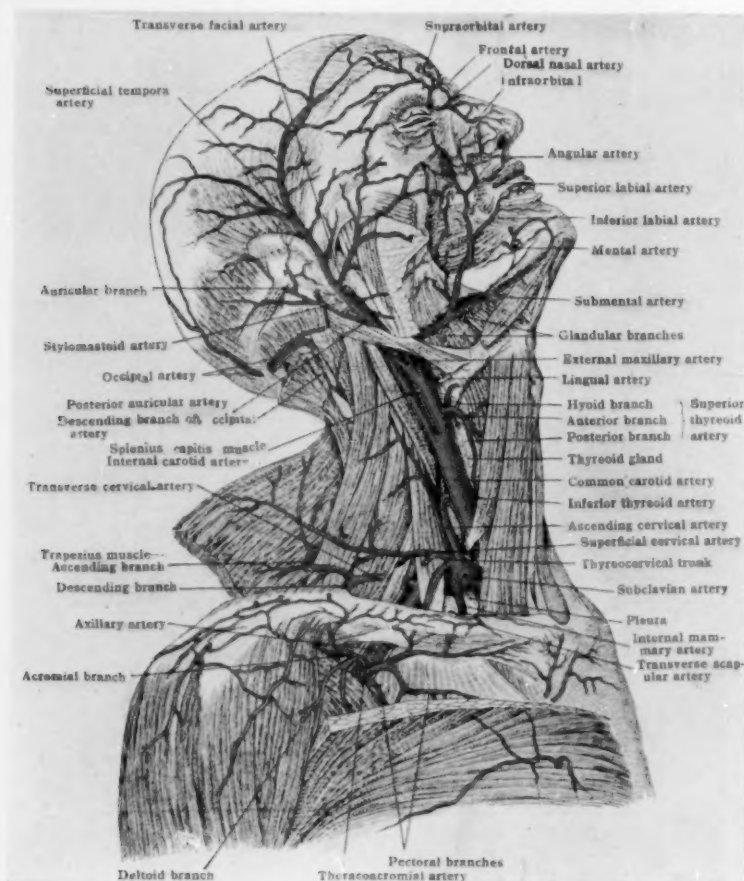


FIG. 14.—Arteries of the head and neck. (After Toldt, "Atlas of Human Anatomy," Rebman, London and New York.)

performed by Murray (New York) in 1904. Up to 1907, (de Schweinitz) there had been six cases reported with one cured, four improved, one negative, and no fatalities. The case which was cured died one month later from rupture of an aneurism of carotid near aorta. Since 1907, there have been 32 cases in which the internal carotid has been ligated with 28, or 87.51 per cent. cured or improved, and 3 per cent. or 9.37 per cent. mortality. Combining the two series there have been 38 cases in all with 86.84 per cent. cured or improved, and a 7.9 per cent. mortality. If a comparison

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is to be made between these results and those of ligation of the common carotid, the common carotid series must be taken after 1904, because fatalities from infection were greater in the foregoing period.

*Bilateral Ligation of the Common Carotid.*—(with interval between ligations) had been performed ten times before 1907. Since then there have been 11 more cases so treated, making a total of 21, with 61.91 per cent. cured or improved, and with a 14.28 per cent. fatality. (See Table V.)

*Orbital Vein Ligation.*—Ligation of the dilated orbital veins at the inner angle of the orbit for pulsating exophthalmos was performed successfully by Lansdown in 1874. From that time up to the present this operation has been performed in 43 cases with 69.76 per cent. cured or improved, and 11.63 per cent. fatality. In most of the cases in which an orbital operation was performed, the patient had previously had a carotid ligation. This is unfortunate, for the merit of the orbital operation can be justly determined only from those cases in which it was the primary operation. There have been 19 of such cases with 68.42 per cent. cured or improved, and 5.26 per cent. fatality.

*Rest and Medication.*—Of the entire number of cases reported in the literature only very few were cured by simple means such as rest and medication. In de Schweinitz and Holloway's own series, six cases were treated in this manner and of these there was one cured, three improved and two negative. Since then there have been 23 more cases treated in this fashion, making a total of 28 cases of which there have been 4, or 14.29 per cent. cured; 10 or 35.72 per cent. improved, and 13, or 42.85 per cent. negative, and 1 or 3.57 per cent. fatality.

*Gelatin Subcutaneous Injections* for treatment of pulsating exophthalmos introduced by Paulesco<sup>30</sup> had been employed three times up to 1907, with one cure and two improvements. The total cases treated in this manner has now reached 16, of which 5 were cured, 5 improved and 6 negative. Thus 62.50 per cent. of the cases were cured or improved. A warm 2 per cent. gelatin solution has usually been used for the treatment. From 100 to 250 c.c. are injected subcutaneously every 4 to 8 days.

### DISCUSSION AND CONCLUSIONS CONCERNING TREATMENT

The beneficial results from these various forms of treatment are dependent upon the decrease of blood going to or from the arterio-venous fistula, without diminishing the blood supply of that side of the brain sufficiently to cause death or hæmiplegia. In order to reduce these dangers to the very minimum, I believe that a course of carotid compression should precede every ligation operation.

In a given case of pulsating exophthalmos the treatment to be selected will largely depend upon the results of the carotid compression test. The following three examples are illustrative:

1. *If prolonged periods of carotid compression stop the bruit and do not cause signs of cerebral anæmia*, beneficial therapeutic results are to be

expected. This may be interpreted as meaning a sufficient anastomosing circulation from the opposite carotid or from the vertebral arteries to properly nourish the hemisphere, yet not a sufficient supply to maintain the arterio-venous communication. In young individuals this type of case should not have too lengthy a course of carotid compression therapy. Such treatment, if it does not early cure the condition, will merely tend to increase the anastomosing circulation so that a subsequent carotid ligation will not entirely shut off the bruit. In this type of case complete rest, subcutaneous gelatin injections and not less than one week's course of carotid compression in young individuals and three week's course in middle-aged or elderly individuals are to be recommended. In case of failure of these procedures ligation of the carotid, by the method described by the author (see below) is indicated.

2. *If the carotid compression test shuts off the bruit yet gives headache, or motor or sensory signs on the opposite side*, a thorough course of compression is indicated. Complete rest and subcutaneous gelatin injections may be carried on at the same time. The compression treatment should be given 4 to 10 times daily and increased from day to day until it is possible to constrict the artery for an hour at a time without the development of motor and sensory signs on the opposite side of the body. Figure B shows an instrument devised for the purpose of prolonged carotid compression. A thorough compression treatment is especially important in middle-aged or elderly individuals. It will prepare sufficient anastomosing circulation to alleviate the danger of subsequent carotid ligation and will, moreover, give ample time for cure in those cases in which conservative therapy is going to be successful.

3. *If the carotid compression test neither shuts off the bruit nor causes signs of brain anæmia*, then a prolonged course of carotid compression merely for therapy will not be of much value. However, a 1 to 3 weeks course, depending upon the age of the patient, will be necessary for safety as a preliminary measure to carotid ligation. The latter procedure is indicated but the surgeon will not be very confident of success.

By examination of the comparative results of common carotid and internal carotid ligation (Table V) it will be seen that there is but little advantage of one over the other. Between 1907 and 1923 there have been more cured and improved from internal carotid than from common carotid ligation, yet with this there has been a slightly greater mortality. Only as case reports increase in number will it be possible to judge which of these two procedures is the better. Either one is comparatively safe when preceded by a course of carotid compression. Out of the 13 cases in the literature treated in this manner, there were no fatalities nor ill results. It seems to the author that Murray's logic was good in suspecting fewer recurrences after internal carotid ligation. However, without a course of carotid compression it is probable that the mortality of internal carotid ligation would be greater than from common carotid ligation.

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The mortality following carotid ligation may not only be reduced by the pre-operative procedure just mentioned, but also may be materially reduced by certain operative and post-operative precautions. The dangers to a patient from carotid ligation, I believe, are twofold. The first and immediate danger, that of unilateral brain anæmia from lack of blood supply, and the second, the danger from embolus or an extension of a thrombus,<sup>†</sup> which may cause an accident some days after the ligation. Both of these dangers may be minimized at the operating table by the procedure employed by the author.

*Method of Carotid Ligation.*—Under local anæsthesia the carotid is exposed, gently compressed and shut off with a Crile clamp. This temporary obliteration is maintained for a period of one hour. During this interval the wound is covered with gauze moistened in Ringer's solution and the patient is asked frequently whether there is headache, or feeling of numbness or weakness, etc., of the opposite extremities. Objective tests are also made. Should any signs develop, the clamp is immediately released, and the ligation abandoned until a later date after another course of digital compression. The danger of embolus and thrombosis I attempted to minimize by keeping the patient absolutely quiet for the first week after operation. He is told not to move at all, not even his arms and legs, and he is fed, turned and waited upon hand and foot by the nurses and orderlies. What is more, in the ligation itself, care is used to employ a ribbon ligature which is tied only tight enough to shut off the artery and not tight enough to injure the walls of the vessel.

Should ligation of the carotid fail and if there is a persistent enlargement and thrill of the ophthalmic veins and their branches, I believe that a ligation of these distended vessels is indicated. Even this operation although seemingly simple has a considerable mortality and with a smaller percentage of cures and improvements than carotid ligation. It should then be employed when carotid ligation has failed and under no condition should an attempt be made to do an orbital vein ligation and a carotid artery ligation at the same sitting. The results have been exceedingly unfortunate in the cases so treated. After a distal ligation of the orbital veins their lumina no doubt become filled proximally with organized clot. The extent of this process to the opening of the arterio-venous fistula is probably responsible for the cures that sometimes follow.

In case neither ligation of the internal carotid nor of the superior ophthalmic vein effects a cure, ligation of the opposite carotid may be performed. However, because of the high mortality accompanying this procedure the surgeon must assure himself by prolonged periods of digital compression that no accidents will follow. The method suggested by the author, of operating under local anæsthesia and temporarily occluding the carotid before its permanent ligation should reduce the danger of this operation.

<sup>†</sup> De Fournestraux: Les accidents cerebraux et Oculaires consecutif a la ligature de la Carotide Primitive. These, 1906-1907, No. 292.



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- <sup>29</sup> Rawlings: Barth. Hosp. Rep., 1904, vol. xl, p. 75.
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## CHRONIC PRODUCTIVE THYROIDITIS

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CHRONIC productive thyroiditis, Riedel's iron-hard struma, benign granuloma of the thyroid (Ewing), or ligneous thyroiditis (Delore) is rather a rare lesion of the thyroid gland. The reports of the following three cases may, therefore, be of interest.

CASE I.—White female, thirty-five years of age, the mother of one child, thirteen years old both of whom were syphilitic. The patient had six miscarriages, all before the third month, without apparent cause. She had not been pregnant since her second marriage, which took place six years before she came under observation. Four years prior to the time the patient came under observation, she took thyroid extract for a period of one year, for obesity; it did not have any effect on her weight, but produced marked palpitation of the heart. In October, 1904, the patient began to suffer from attacks which were said to be asthmatic. In January, 1905, the symptoms still continued and, in addition, there was dyspnoea on exertion, wheezing at times without exertion, and almost constant hoarseness, except for periods of a few days.

In January, 1905, when the patient's symptoms became aggravated, she consulted Doctor Huddleston, who noticed slight enlargement of the thyroid. He placed her on mixed treatment, consisting of potassium iodide and protiodide of mercury. There was no change in the swelling or other symptoms and, during March, 1905, she frequently had fever, ranging from 100 to 101° F., and occasional chills.

In April, 1905, the patient came under the observation of Drs. W. T. Bull and Eugene H. Pool. At that time she showed marked dyspnoeal distress, with shallow rapid, wheezing respiration. The pulse was rapid and irregular; heart and lungs negative; no evidence of syphilitic lesions on skin or elsewhere. Over the lower part of the neck there was a slight fullness, suggesting a diffuse goitre; this area was very hard, especially on the left side and in the region of the isthmus of the thyroid gland. Examination by Doctor Lefferts showed the vocal cords to be normal, but the tracheal walls on both sides were compressed, narrowing the lumen of the larynx to a slit-like orifice.

On April 22, 1905, the patient was operated upon by Dr. W. T. Bull, assisted by Dr. Eugene H. Pool under chloroform anaesthesia. A median incision was made from the incisura of the thyroid cartilage to the sternum, and a horizontal incision, 2 inches long, on the left side, from the centre of the vertical incision. At the site of the cricoid cartilage and the trachea, for a distance of one inch, there was a smooth, bony hard tissue, cutting like cartilage, apparently  $\frac{1}{4}$  inch thick, and inseparable from the trachea. Laterally it seemed to embrace the tracheal tube closely. The thyroid gland was not indentified. The trachea was opened just above the plane passing through the upper limit of the sternum, and a tracheal tube was inserted. The tissues were then sutured.

Five days after the operation, the patient developed erysipelas and died after a sudden arterial hemorrhage.

Post-mortem inspection by Doctor Pool showed a thyroid of about normal size and very hard, constricting the trachea and obstructing its lumen, as described by Doctor Lefferts. There was nothing pathologic in any of the tissues adjacent to the thyroid. The thyroid was composed of connective tissue, evidently a replacement fibrosis, except

for a small area at the right upper pole, about 1 cm. in diameter, which showed some evidences of acini in various stages of obliterative compression. The histological sections showed a chronic inflammatory process with obliterative endarteritis.

*Pathological Diagnosis.*—Chronic productive thyroiditis—non-luetic.

CASE II.—Lieutenant-Colonel, A. P. S., white male, twenty-five years of age, Russian aviator, was admitted to Presbyterian Hospital, New York, on December 9, 1919 (No. 44229), service of Dr. G. E. Brewer, with a history of swelling in the neck in the region of the thyroid, dyspnoea, and difficulty in swallowing; onset some three

months prior to admission. Past history irrelevant; venereal history denied.

Physical examination was negative, except for dyspnoea, polynoea, and the presence of a mass, about the size of a hen's egg, intensely hard, corresponding to the position of the right lobe of the thyroid.

On December 9, 1919, the patient was operated upon under general anaesthesia. An incision 6 inches long was made along the anterior margin of the sterno-mastoid muscle on the right side, with extension downward over the right sterno-clavicular joint. The right lobe of the thyroid was involved by a new growth which extended out and into the surrounding

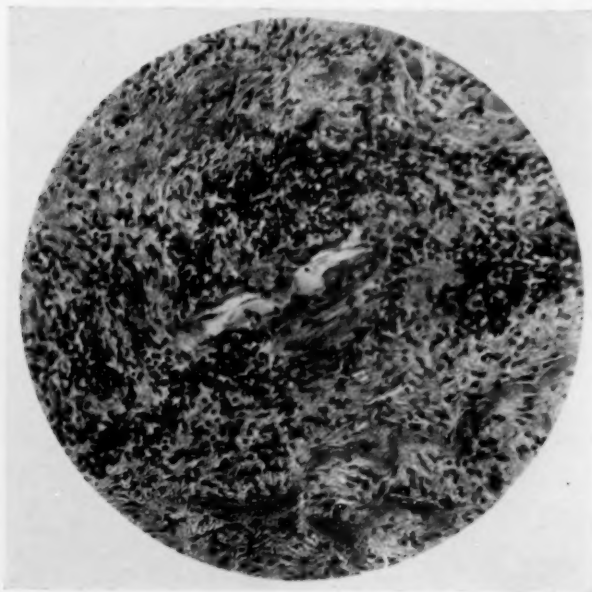


FIG. 1.—Case I.

tissues, causing great increase in the density of the capsule of the gland, enclosing the recurrent laryngeal nerve and extensively adherent to the trachea and oesophagus. The lower pole of the tumor was well below the clavicle. The consistency of the tumor was very hard and it was only slightly movable. There was increased vascularity of the region.

*Procedure.*—Incision deepened through platysma; sterno-thyroid and sterno-hyoid muscles were divided across, the former being noticeably adherent to the right lobe of the thyroid. The capsule of the gland was exposed with great difficulty. Numerous branches from both the superior and inferior thyroid arteries were ligated. In order to free the inferior pole and to make sure of controlling hemorrhage from the inferior thyroid vessels, the incision was extended down over the sternum and a subperiosteal resection of the inner 3 cm. of the right clavicle was performed with a Gigli saw. The inferior thyroid vessel was then doubly ligated and the gland was removed by sharp dissection along the right aspect of the trachea. In this region considerable new growth was left where it had become incorporated in the wall of the trachea. This was done because it was manifestly impossible to remove the 2 or 3 inches of trachea apparently involved. The superior thyroid vessels were ligated and removal of the right lobe completed. A large rubber tube was split and used to cover the carotid artery and jugular vein. One hundred and twenty mgs. of radium were inserted in a small rubber tube and placed alongside the above-mentioned portion of trachea, the lower end of the

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tube being in the lowermost depth of the wound. Incision closed by plain interrupted sutures for muscles, silkworm interrupted sutures for skin.

Respirations labored due to pressure on trachea. Time of operation 1 hour, 33 minutes. Time of anesthesia 1 hour, 40 minutes.

Radium removed on December 10, 1919, 3:30 P. M., and wound dressed.

December 16, 1919, marked difficulty in swallowing.

December 21, 1919, radium applied for 4 hours.

Subsequent progress of patient uneventful. Discharged as cured on January 3, 1920. No recurrence of symptoms; patient alive and well 4 years after operation.

*Pathological Report.*—The gross specimen consisted of thyroid tissue, seemingly one lobe, and 3 cm. of the extremity of the clavicle. The dimensions of the thyroid were 3 cm. in length,  $4\frac{1}{2}$  cm. in width and  $4\frac{1}{2}$  cm. antero-posteriorly. The tissue was hard and firm, definitely encapsulated, with no regularity on the surface. The mid-portion of the thyroid was almost stony hard. On section, at about its centre, corresponding to the area of extreme hardness, there was about 0.9 cm. of soft succulent material. Around this the tissue was hard and firm, and in the upper portion of the gland the same succulent material was found. The tissue comprising the thyroid bore no resemblance to the normal thyroid tissue. The bone presented no unusual abnormalities.

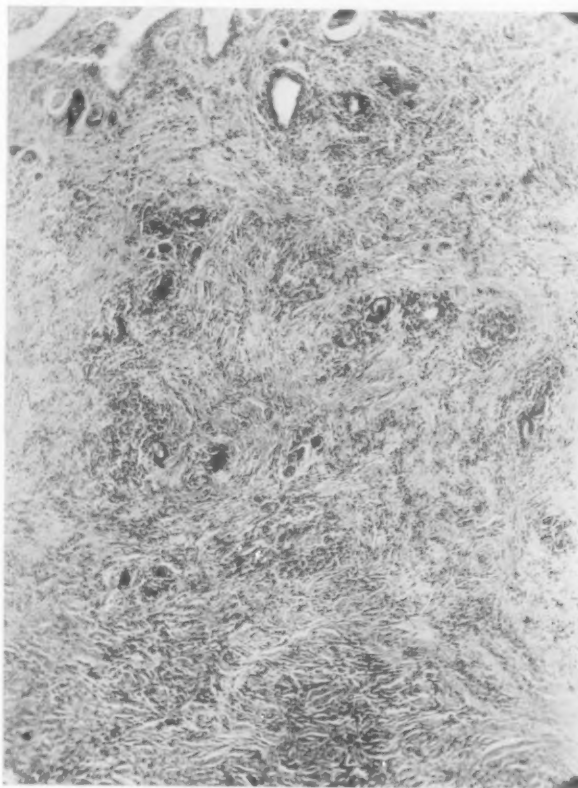


FIG. 2.—Case II.

*Microscopic Examination.*—The bulk of the tumor mass is made up of exceedingly diffuse connective tissue, infiltrating between the acini of the thyroid. This connective tissue is degenerated, forming dense bands. There are round cells sparsely scattered throughout this dense mass, and at points between the thyroid acini. The degenerative phenomenon suggests the precursor of calcification and ossification. The picture is that of an exceedingly chronic inflammation. It suggests the site of an injury with hemorrhage, repair and inflammation. *Diagnosis:* Chronic inflammation (W. C. Clarke).

*Note.*—"A review of these slides (No. 23773) after reference to Ewing's book 'Neoplastic Diseases' leads me to suppose that this case corresponds to Riedel's iron-hard struma." (A. P. Stout.)

*CASE III.*—This case occurred in the author, a white male, thirty-one years of age.

*Previous History.*—Measles, catarrhal croup, chicken-pox in infancy. Several attacks of tonsillitis; occasional attacks of gastric disturbance during childhood. In-

fluenza (severe) while in France in 1918, again in 1920. The last attack of influenza was followed within two weeks by an attack of nasal diphtheria. Prior to 1911, the patient was rather thin and under-weight. During the summer of 1911, however, there was a sudden gain in weight (about 20 pounds within five weeks), after which hair on scalp began gradually to fall out. In December, 1922, noticed that neck was becoming larger.

In March, 1923, the patient experienced difficulty in swallowing food, which gave the sensation of being "caught" in the œsophagus and, in the case of liquids, there was

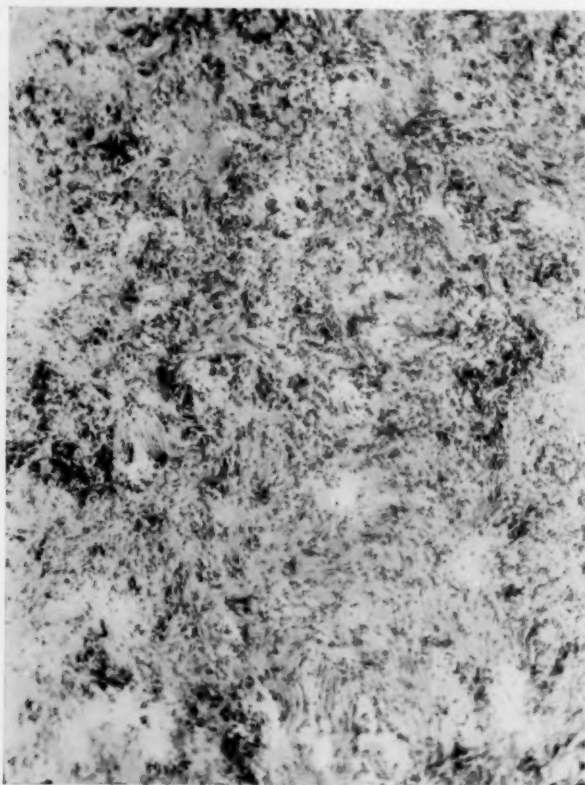


FIG. 3.—Case III.

regurgitation at times. Some dyspnoea on exertion was also noticed. The symptoms continued and seemed to become aggravated, particularly the difficulty in deglutition. Carcinoma of the œsophagus was thought of, but the peculiar history of difficulty in swallowing did not coincide, i.e., solid food (meat) often gave no symptoms, whereas liquids, particularly cold drinks, seemed to produce a spasm in the pharynx and regurgitation, or repeated efforts at swallowing. Pains, aching in character and at times knife-like, girdled the upper portion of the thorax, coming on without apparent cause, not related to swallowing, and usually of short duration. X-rays of the œsophagus and gastro-intestinal tract revealed no abnormalities. X-rays of the chest and thoracic spine showed no pathologic process.

*Physical examination* by Dr. N. Stadtmüller showed a well-developed, somewhat

obese male. The heart was slightly hypertrophied to the left by percussion (negative by X-ray); average pulse rate 116; blood-pressure 110-85; average temperature 99.6; urine negative; weight 217 pounds dressed; height 5 feet, 10½ inches; Wassermann reaction negative (Wassermann in 1913 negative); remainder of physical examination negative.

On July 3, 1923, the patient quite accidentally, on turning his head to the left, noticed a hard swelling protrude just above the sternum and in the region corresponding to the right lobe of the thyroid. This was diagnosed as a calcified thyroid adenoma. X-ray showed no calcification, but marked displacement of the trachea to the left. On July 24, 1923 the tumor in the neck appeared slightly larger. Dr. F. Torek was consulted and operation advised.

*Operation.*— July 26, 1924, under local anaesthesia. Platysma divided; right thyroid exposed and found adherent to sterno-thyroid and sterno-mastoid muscles. Former divided, disclosing a hard tumor mass, about three-fourths the size of a hen's egg, firmly



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adherent to the trachea. Right lobe and part of isthmus removed, after considerable difficulty in separating it from the trachea. Recurrent laryngeal nerve intact. Muscles sutured with interrupted chromic catgut; skin with interrupted silk worm gut.

*Post-operative Course.*—Hoarseness of the voice was noticed on the second or third day following the operation. Recovery was uneventful, except that the wound drained for about one month, discharging small amounts of brownish, clear fluid. Unilateral paralysis persisted and still exists (8 months post-operative). This condition is thought to be a unilateral paralysis due to a "pulling" injury without severing the nerve, and resulting in a degenerative neuritis from which complete recovery is expected.

*Pathological Report.*—The specimen consisted of an ovoidal mass removed from the thyroid, measuring about 4 cm. in length and 2 cm. in thickness, with some muscle tissue attached. The mass had been cut down the centre and was stony hard in consistency, presenting an irregularly granular, cream-colored surface.

*Microscopic examination* showed the presence of a chronic productive inflammatory process in which there was considerable hyalinization of connective tissue. In the microscopic sections the inflammatory tissue was seen invading adjacent muscle fibres. There was nothing in the growth to suggest a neoplasm.

*Pathological Diagnosis.*—Chronic productive inflammation of thyroid gland. (Douglas Symmers).

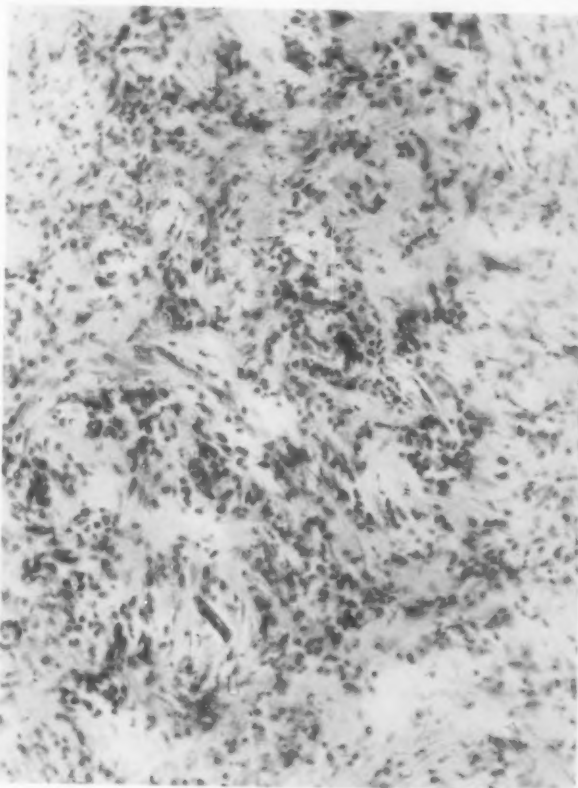


FIG. 4.—High power section of Case III.

Citation of the above three cases is made in some detail because of the lack of literature on this peculiar condition. Chronic productive inflammation of the thyroid, such as described by Riedel, is referred to only in one English text-book, so far as I can ascertain, and, except for the publication of one recent case report, no other mention is made of the lesion. In the foreign literature likewise there is only Riedel's original communication, one by Bruno Selitscheck, and one or two references by French writers. Hashimoto, in 1912, reported several cases in which there was marked round-cell infiltration.

Although the lesion is relatively rare, it nevertheless forms a definite pathological entity. Ewing has seen four of these cases, all without re-

currence after removal. Crile, in his experiences in thyroid disease at Lakeside Hospital, has encountered thirteen well-defined examples. At the Mayo clinic forty-eight cases were encountered amongst ten thousand five hundred thyroidectomies.

The etiology is obscure. Pool suggested the possibility of lues as a cause in view of his experience with one case. Riedel's original contention, *i.e.*, that it is the result of an infection, is somewhat indefinite. Some text-books suggest that acute suppurative and non-suppurative thyroiditis results from severe infections, such as diphtheria, scarlatina, typhoid, etc., whereas chronic thyroiditis results from comparatively mild infections, such as tonsillitis, la grippe, etc. These etiological factors seem equally vague and indefinite and are probably based somewhat on Riedel's work. Ewing does not believe that syphilis is a factor nor that it is related to a true tumor process.

Replacement fibrosis of a degenerating adenoma is possible, though degeneration in these tumors is generally in the form of a cystic degeneration. The possibility of hemorrhage into the thyroid as a result of disease or trauma to a vessel, with subsequent replacement fibrosis in a manner analogous to the development of a uterine fibroid, is likewise, though to a less extent, open to the same criticism.

#### CONCLUSIONS

1. Riedel's iron-hard struma is analogous to chronic productive thyroiditis.
2. It is a comparatively rare lesion.
3. Its etiology is obscure, though the possibility of its pathogenesis in the form of an end-process, in association with infections, adenomata and organization following hemorrhage must be considered.
4. It is generally considered malignant clinically, but its benign nature is apparent upon histologic examination. No recurrence has been reported in the literature.
5. Operative removal is the usual form of treatment. However, it may be well worth while to attempt its removal by radium or Röntgen-ray treatment, providing the benignity of the lesion is first established.

I wish to thank Doctors Pool, Brewer, Torek and Stadtmuller for permission to publish these cases; Drs. W. C. Clarke, A. P. Stout, Douglas Symmers, James Ewing, George W. Crile and John de J. Pemberton for their personal interest and aid, and especially Dr. J. E. McWhorter, who first called my attention to Riedel's struma and rendered much aid in preparing this paper.

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## THE PRESENT STATUS OF THE SURGICAL TREATMENT OF CHRONIC DUODENAL AND GASTRIC ULCER\*

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THE surgical treatment of chronic duodenal and gastric ulcer is still a matter of controversy both as to operative indications and the best type of procedure. As the two groups present radical differences in pathology prognosis and surgical management it is well to consider them separately. Acute perforations will not be considered in this paper as the problems involved are quite distinct and demand special consideration.

*Chronic Duodenal Ulcer.*—As to indications for surgical treatment in this group most surgeons differ less from the medical viewpoint than is popularly supposed. They are quite content to let the internist treat these cases, as long as physician and patient are satisfied that treatment gives relief and a cure is being effected.

We agree with the internist that early uncomplicated cases should first receive medical treatment and that a considerable number of patients are cured or at least kept in reasonable comfort thereby for long periods of time. It is a well recognized fact that many patients prefer to bear recurrent periods of discomfort, rather than submit to the hazards of an operation, and are willing to accept a certain percentage of risk as to the possible occurrence of hemorrhage, perforation or obstruction.

The surgeon has no quarrel with such patients provided they have a clear understanding of the situation. Ample opportunity for surgery exists in patients who fail to respond properly to medical treatment; in those unwilling to endure repeated relapses, and in cases in which complications threaten or occur.

We prefer that patients should have had a thorough and intelligent trial of medical treatment before surgery is considered and have repeatedly expressed this view to patients with early symptoms of short duration, a fair number of whom never come to operation. I would emphasize especially those in whom a hasty or ill-founded diagnosis has been made unsupported by adequate clinical symptoms. While I wish in no way to disparage positive X-ray evidence of ulcer so often valuable and unmistakable, I do feel that the greatest care should be taken in the interpretation of short series of doubtful plates. Cole's insistence on the need of a sufficient number of plates for safe interpretation has been a great advance in this particular diagnostic field. The Röntgen diagnosis of adhesions about the duodenum and gall-bladder giving the impression that ulcer or some surgical lesion may be present, with-

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\* Read before the New York Surgical Society, February 27, 1924.

out venturing a positive opinion, must also be taken with caution as we have seen many negative explorations in such cases.

To return to the management of uncomplicated chronic duodenal ulcer, which has resisted medical treatment; in which the diagnosis after careful study seems reasonably certain, and in which the need for surgery of some sort is conceded. We have been considerably disturbed by the tenor of several papers and discussions, and the attitude of a number of prominent surgeons

as expressed at recent important meetings, notably in the New York Surgical Society during the past year; at the Clinical Congress of Surgeons held in Chicago in October, 1923, and at the last meeting of the Southern Surgical Association.

The attitude which disturbed us was the tendency to advocate radical measures of resection, often of large portions of the healthy stomach for the surgical cure of this disease. We cannot subscribe to the recent wave of enthusiasm for these radical methods, which seems to be gaining so many advocates. A distinguished foreign surgeon has recently been demonstrating partial gastrectomy under local

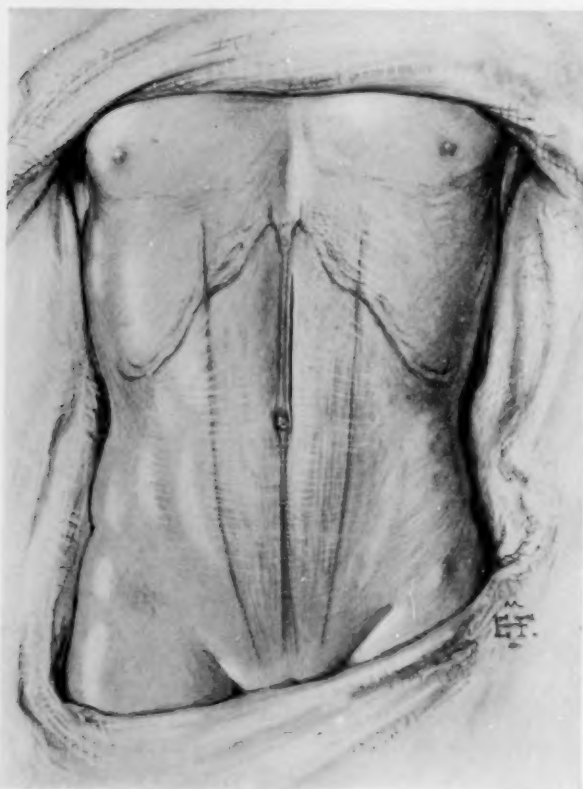


FIG. 1.—The incision is made a little to the left of the linea alba, above the umbilicus. The operator stands on the patient's left. This incision falls directly over the point of anastomosis, in line with the cardiac orifice and the duodeno-jejunal junction.

anæsthesia for this type of case, removing a considerable portion of the healthy stomach for the purpose of getting rid of small uncomplicated duodenal ulcers. One of the arguments advanced in support of the procedure is that it lessens or removes the danger of the subsequent development of gastro-jejunal ulcer, which occurs in about 2 per cent. of cases following gastro-enterostomy. Von Haberer, of Innsbruck, advocates extensive resection followed by gastro-duodenal anastomosis, a modification of the Billroth I method of gastric resection, and has numerous admirers and imitators in this country. One of the soundest and safest of our American surgeons has recently brought forward a method of excision in which the

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cut end of the stomach is anastomosed to the side of the mobilized duodenum, the cut end of which has been closed by a purse-string suture, *i.e.*, a new type of pylorectomy. He has never liked gastro-enterostomy nor has he practised it to any extent in his clinic. When he refers to it in discussions it is generally to condemn it and to cite some case in which it has failed to relieve the condition for which it was done.

Our own experience and belief is that simple gastro-enterostomy properly performed, is curative and adequate in the great majority of chronic duodenal ulcers: that from 80 per cent. to 90 per cent. of the patients so treated are completely relieved of their symptoms and remain well as they are followed year after year: that the operation is as successful in the average case without obstruction as in those with it: that malignancy develops so rarely as to be a negligible factor in prognosis. We do not believe in nor have we practiced any method of pyloric exclusion; our experience with this procedure therefore is nil. We have yet to see reported any series of cases which would support the claims made by the advocates of this procedure. The viewpoint of surgeons who believe in this method who we have heard discuss the question has been quite theoretical and unsupported by any considerable amount of experience.

We have certain ideas as to why gastro-enterostomy so often effects a cure in chronic duodenal ulcer, and believe that mechanical and chemical factors in its etiology have a distinct bearing on the results. The ulcers nearly all develop within  $1\frac{1}{2}$  inches of the pylorus, the part of the duodenal wall subjected to the impact of spurts of acrid stomach content, pumped intermittently through the pylorus as though by the piston of a powerful syringe. This stomach content is often equivalent to a strongly irritant or even corrosive chemical compound, not entirely dependent on the amount of hydrochloric acid present for its irritant character. When we think of the combinations of food and drink with which most of us from time to time insult our gastro-intestinal tracts, it is not surprising that by the time the mess is pumped in spurts through

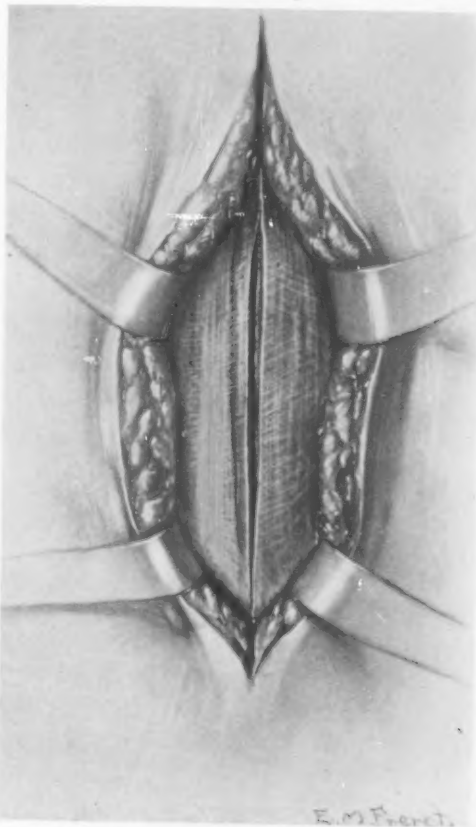


FIG. 2.—The incision leaves just enough of the edge of the rectus sheath to assure secure closure of the abdominal wall.



the pylorus, it is acrid enough to cause definite injury to the delicate duodenal mucous membrane. When the ulcer is once formed, as Codman well says, it may be likened to a fissure in ano; an ulcer within the grip or influence of a constantly moving sphincter, irritated by the impact of acrid stomach content, with little chance to heal and every chance to become deeper and develop a zone of chronically irritated and inflamed tissue around it.

Gastro-enterostomy modifies both chemical and mechanical influences:

1. It lessens the irritant character of the stomach content, partly by shortening the length of time in which it is churned about in the stomach; partly by actual diminution of the acidity.

2. It greatly lessens the amount of stomach content still passing through the pylorus, even when there is no obstruction, and also the force of impact on the ulcer area of that which does pass.

Whatever the real explanation may be, we have abundant clinical evidence that duodenal ulcers heal after gastro-enterostomy; that they remain healed and that patients are permanently cured by their symptoms in a large percentage of cases so treated.

We do not believe that gastro-enterostomy should go into the discard in the treatment of duodenal ulcer nor do we believe that extensive resections of normal stomach are justifiable for this lesion.

We are unconvinced that resection to prevent the formation of

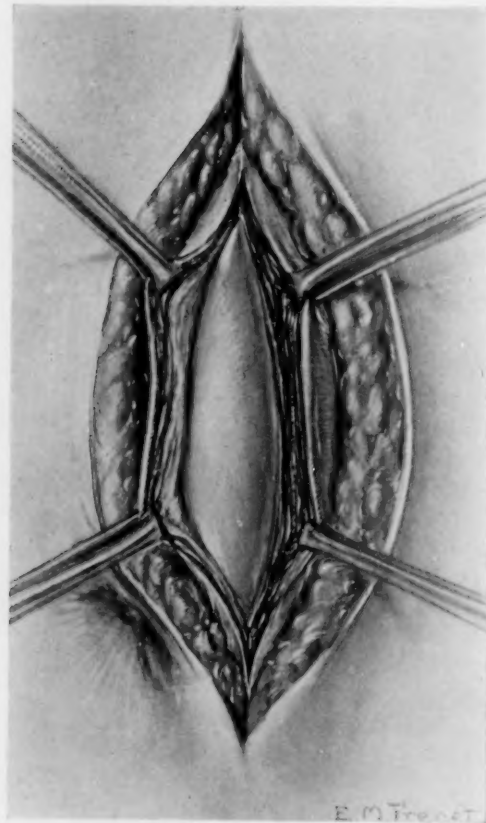


FIG. 3.—The incision leaves just enough of the edge of the rectus sheath internally to assure secure closure of the abdominal wall.

gastro-jejunal ulcer is a proper procedure in the ninety-eight cases who do not need it to possibly avoid its occurrence in the other two. The other two might well be dead before the hundredth case is reached if this were made a routine operation. Moreover we believe that with a well-planned and uniformly executed technic for gastro-enterostomy that even the 2 per cent. of gastro-jejunal ulcers may perhaps be reduced to a lower figure.

The choice of procedure is a problem of prime importance and depends to some extent upon the pathologic type of the ulcer. For a better understanding of this it is well to group the cases into general types: Leaving out acute per-

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forations which constitute a special problem, four such groups will be sufficient for our purpose.

1. Small, single, anterior wall ulcers, without narrowing of the gut, susceptible of local excision, without encroaching on the duodenal lumen or pylorus to any extent. As recently pointed out by Judd and Rankin, local excision without gastro-enterostomy is quite sufficient in this type; but the percentage of ulcers suitable for this procedure is limited.

2. Chronic indurated ulcers without obstruction; single or multiple. We include in this group ulcers of the chronic perforating type; with adhesions fixing the duodenum or inflammatory mass. A majority of all duodenal ulcers fall in this class.

We have had many cases of chronic perforating ulcers without hemorrhage, but with extensive adhesions, fixation of the duodenum, sometimes a considerable inflammatory mass. In many of these cases radical resection would be difficult, hazardous or quite impossible. If resorted to at all in this type it is well to do a gastro-enterostomy first, following by resection as a two-stage procedure ten to fourteen days later. The inflammatory mass may be found greatly diminished in size, fixation

less marked, and radical excision much easier and less dangerous. We believe, however, that gastro-enterostomy alone will cure a large percentage of these cases and that more radical methods are generally unnecessary and unwarranted.

3. Cases with duodenal stricture or so-called pyloric stenosis, a group in which gastro-enterostomy is the ideal operation, and in which there is the least controversy as to its efficiency. In no field of major surgery are the results of a relatively simple operation more brilliant and lasting.

We have repeatedly operated upon cases with the strictures so tight, and



FIG. 4.—An opening is made in the transverse meso-colon (insert A) and the stomach drawn through. Shallow curved Moynihan clamps are placed on stomach and jejunum. A point on the stomach is selected near the greater curvature, directly in line with the cardiac orifice, and overlying the duodenal junction, usually about  $3\frac{1}{2}$  inches to the left of the pylorus. From this point the line of the clamp runs a little obliquely to the left, toward the lesser curvature (insert B). The jejunum is grasped about 3 inches from its origin. The distal point on the jejunum must correspond to the point nearest the greater curvature on the stomach. Stomach and jejunum are joined by a continuous stitch of linen or gut for a distance of  $2\frac{1}{2}$  inches. Openings  $1\frac{3}{4}$  inches long are then made in each viscus.

starvation and dehydration so extreme, that the condition at the time of operation was most critical.

Preliminary hypodermoclysis; blood transfusion and operation under local anæsthesia often aid in obtaining a successful outcome.

4. Cases in which severe hemorrhage has occurred, single or repeated. Hemorrhage occurs most frequently in deep penetrating ulcers on the posterior wall or against the head of the pancreas; often also in multiple ulcers.

We have seen patients die of duodenal hemorrhage before any operation

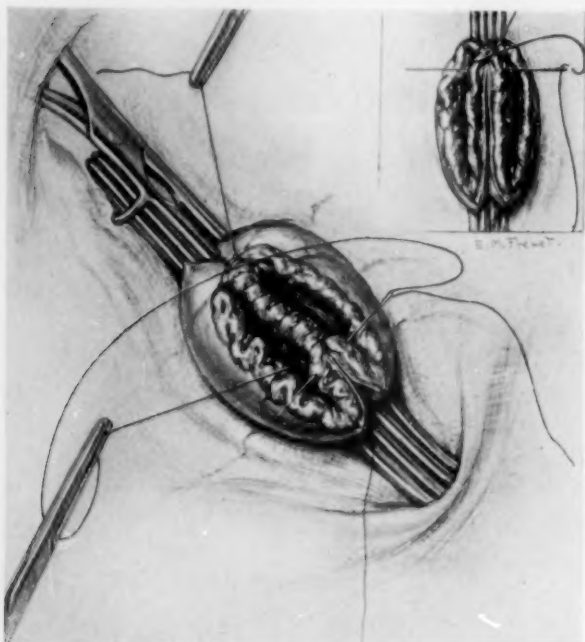


FIG. 5.—The cut edges of the posterior half of the opening are sutured with a simple continuous stitch of tanned gut. Care is taken that each stitch shall include all layers of the wall of both stomach and jejunum (insert); that spacing shall be accurate, and tension just enough to secure firm contact without blanching the tissues. The mucous membrane is purposely left redundant to insure accurate apposition, and complete covering of cut edges. Absolute hæmostasis is insured if this suture is properly made.

could be performed; cases so exsanguinated that preliminary blood transfusion alone made operation possible.

Gastro-enterostomy is not a guarantee against recurrence of hemorrhage which may prove fatal. If the patient's condition permits, excision of the ulcer area is desirable in this group. If the danger of radical excision seems too great in exsanguinated or debilitated cases, gastro-enterostomy may be sufficient or it may be done as the first step of a two-stage operation. It is our belief that the average duodenal ulcer heals within two or four weeks after gastro-enterostomy, but fresh hemorrhage may

occur before time for such healing has elapsed. Repeated blood transfusions in moderate amounts (300 to 500 c.c.) is especially valuable in these cases.

We have had several hemorrhage cases in which gastro-enterostomy has effected a cure without return of the bleeding; and a few cases in which we have performed immediate pylorotomy. We were once reluctantly forced to operate on a woman seventy-four years of age for repeated duodenal hemorrhage extending over a period of fifteen months. Simple gastro-enterostomy was done, there was no recurrence of hemorrhage and she is alive and well, eating heartily, without symptoms at the age of eighty-three. We have found that hemorrhage either from stomach or bowel or both occurred in about 14 per cent. of our cases.

We believe that radical resections should be reserved for the small per-

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centage of cases in which gastro-enterostomy has failed to relieve the ulcer syndrome; for certain hemorrhage cases; cases of inflammatory mass in which malignancy may be suspected (a two-stage procedure), and possibly for the 2 per cent. in which gastro-jejunal ulcer develops. If gastro-enterostomy is to be successful and free from complications, it is essential that a well thought out, routine technic should be employed. In perhaps no operation are slight errors in detail more fraught with danger of subsequent trouble.

We are quite aware that our own method is not the only good one, but in our experience it has proved satisfactory and free from early or late complications. We believe that every surgeon should carefully work out the details of the routine which in his hands gives a uniformly smooth post-operative course. We have had only two cases of vicious circle, on our series, both occurring in cases in which the gastro-enterostomy had to be done through an incision planned for other work

owing to an error in pre-operative diagnosis. Both cases recovered after secondary entero-enterostomy and are now well and free from symptoms at seven years, ten months, and three years ten months respectively.

*Operative Technic.*—There are several points in technic which we believe to be of importance in the operative procedure.

Our own routine is to stand on the patient's left, and make a left paramedian incision. This falls directly over the site where the stoma is to be made, and where the duodeno-jejunal junction lies. The stoma is placed at the most dependent part of the greater curvature, in a line directly below the cardiac orifice. First the stomach, then the jejunum are grasped with shallow curved Moynihan stomach clamps. The placing of the clamp on the stomach

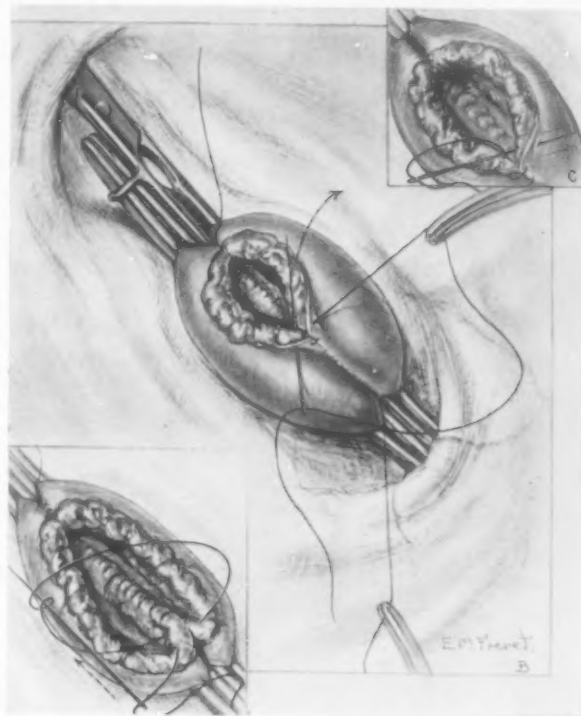


FIG. 6.—A double half hitch locks the stitch at the turn (insert A). The return stitch for the anterior half is exactly the same except that separate thrusts of the needle through each edge are necessary; the redundant mucous membrane serves the same purpose as on the posterior half. A sufficient amount of tissue must be included in each stitch to insure against cutting through. The tie is made to the end left long at the start. The outer tier of Lembert stitch is completed in the same way.

is important; the line is from greater curvature upward and to the left. Great care must be taken to see that the point nearest the greater curvature corresponds to the distal point on the jejunum. The jejunum is grasped about 3 inches from the duodeno-jejunal junction. The clamps are locked; all viscera except the portion in the grasp of the clamps, are replaced within the abdomen; and hot towels protect the wound beneath the clamps. A simple whipover suture of linen is used for the outer tier, the posterior half of which



FIG. 7.—The cut edge of the opening in the meso-colon is anchored to the stomach with interrupted plain catgut, care is taken that the distal point of the anastomosis corresponds to the low point (nearest the colon) of the opening of the meso-colon. This fixes and controls the position of the stoma; and the meso-colon drops over the suture line giving it additional protection.

first joins stomach and bowel wall for a length of  $2\frac{1}{2}$  inches. Openings  $1\frac{3}{4}$  inches long are then made in stomach and jejunum, escaping content being carefully caught on sponges.

No individual vessels are caught and the mucous membrane of both stomach and bowel is purposely left redundant. This insures perfect covering of the cut edges of stomach and duodenal walls; leaves no cracks into which gastric juice can seep, and is an important factor in the prevention of subsequent gastro-jejunal ulcer. The posterior half of the inner tier is then made with special tanned catgut, a simple continuous whipover stitch, great care being taken to see that every stitch includes all

layers of stomach and gut walls; that spacing is accurate and tension constantly maintained, just enough for firm contact without blanching the tissues. Post-operative hemorrhage cannot occur if this suture is properly placed. A double half hitch to lock the suture is taken at the turn, and the same whipover stitch is continued back completing the anterior half of the inner tier. Separate thrusts of the needle through each edge are necessary on this return stitch, and the same extreme care is taken with spacing, tension and mucous membrane edge approximation. The tie is made to the end of the same suture left long at the start. The anterior half of the linen outer tier stitch is then



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completed. The stoma almost uniformly measures  $1\frac{3}{4}$  inches in the clear and the outer line of suture  $2\frac{1}{2}$  inches. The clamps are removed, and the low point of the edge of the opening in the transverse mesocolon, (*i.e.*, the point nearest the wall of the colon) is attached to the stomach wall at the distal end of the stoma, with interrupted fine catgut. Similar sutures complete the attachment of the edges of the mesocolic opening to the stomach. This step is important as it prevents herniation of the gut; allows the mesocolon to cover and protect the suture line, and maintains proper position of the stoma, which now lies vertically, the jejunum pointing directly downward, and swinging easily from side to side.

The belief that the stoma frequently contracts after gastro-enterostomy in cases in which the pylorus remains patent has long been disproven by X-ray studies made years after the operation in many cases. We believe that a painstaking technic with careful apposition of the cut edges of the mucous membrane which prevents open cracks in the suture line left to heal by granulation, does much to guard against the formation later of a contracting cicatricial ring.

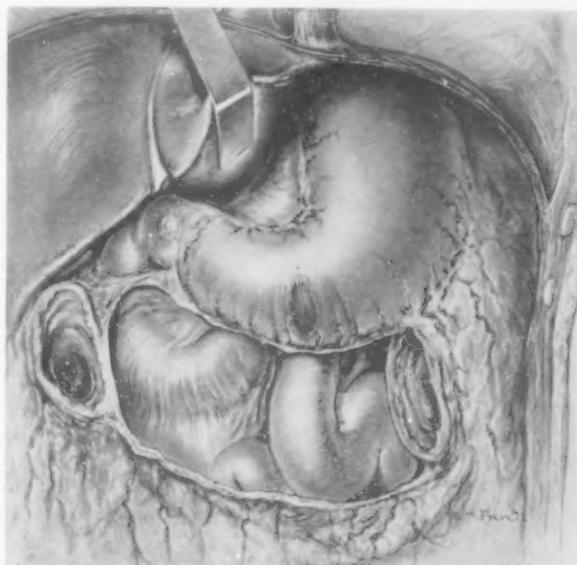


FIG. 8.—The stoma lies directly below the cardiac orifice and over the duodeno-jejunal junction; a little to the left of the midline. It swings easily from side to side as the stomach fills and empties.

We have had no case of post-operative hemorrhage in the series, a fact which adds to our feeling of confidence that the method of suture employed ensures complete hæmostasis. We believe that in the various types of running mattress stitch, vessels may be "jumped" and left to bleed in occasional instances. As far as we know there have been only two proven cases of marginal ulcer, and one suspected which did not come to secondary operation and later became symptom free. We repeat our belief that painstaking apposition of redundant mucous membrane edges safeguard appreciably against this condition.

We have had 196 cases of chronic duodenal ulcer excluding cases of acute perforation; 122 since 1915—in addition to seventy-four cases reported at that time, with sixteen deaths, a mortality of 8 per cent.

Gastro-enterostomy was done in 191 cases; pylorectomy in three; pyloric exclusion in one; simple excision in one.

Cholecystectomy was added in four cases.

The causes of death were:

	Cases
Post-operative pneumonia .....	8
Uræmia .....	2
Cerebral thrombosis .....	1
Pulmonary embolism .....	1
Diabetic coma .....	1
Vicious circle .....	1
Acute dilatation of stomach .....	1
Peritonitis, wound broke open .....	1

Half of the fatal cases were due to post-operative pneumonia. Of these two had cholecystectomy added to gastro-enterostomy, one of them having acute suppurative parotidites in addition to pneumonia; the other a feeble old man sixty-four years of age. In this latter case at least the added cholecystectomy was a fatal error in judgment. A third pneumonia case was a man of sixty-five with advanced chronic nephritis.

The two uræmia deaths were in men of advanced years, with chronic nephritis and alcoholism.

The cerebral thrombosis case occurred in a luetic man of fifty-nine years, who had had severe duodenal hemorrhage.

The diabetic coma in a known diabetic in whom stenosis was of a degree to threaten early death from starvation, a desperate risk deliberately taken.

Excluding pneumonia and the complication cited which are incident to any major operation, the deaths due to the operation *per se*, *i.e.*, peritonitis from breaking open of the wound; acute gastric dilation and vicious circle were only three in number.

There was no case of post-operative hemorrhage in the series and only three cases of vicious circle, two of which recovered after secondary operation.

One case came to secondary operation for gastro-jejunal ulcer, and one eight years after the gastro-enterostomy for persistent pain for a rigid stoma, not greatly contracted. Two others had pain suggestive of this condition, one of whom has cleared up, the other still has symptoms.

Two other patients have had more or less recurrent pain and indigestion. The two vicious circle cases subjected to secondary entero-enterostomy are now symptom free at seven years ten months, and three years ten months respectively.

The known post-operative morbidity in the series has therefore been relatively slight.

*Chronic Gastric Ulcer.*—Chronic gastric ulcer presents problems differing radically from those of duodenal ulcer. Eradication of the ulcer should be a part of whatever operative procedure is adopted. In many cases of ulcers of moderate size, especially in those not situated too near the pylorus we favor local excision or, destruction with the cautery, adding gastro-enterostomy.

The normal peristalsis of a stomach that has been the seat of ulcer is interfered with by the surrounding induration, and after excision by the cicatrix, and for this reason as one factor at least we believe that gastro-enterostomy added to excision gives better clinical results than excision alone.

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Gastro-enterostomy alone will fail to effect a cure of the ulcer in many instances, and the fear of malignancy, either present at the time of operation or as a possible later development cannot be set aside.

Excision or radical resection may, however, be impossible without great risk in large ulcers or those adherent posteriorly; with extensive peri-gastric adhesions, or in old and debilitated subjects. Gastro-enterostomy may be the best procedure available in such cases, and give excellent palliative results or sometimes even a cure. We once operated upon a woman seventy-eight years of age with a large posterior ulcer in the pyloric segment with relief of symptoms for more than two years.

In ulcers near the pylorus, partial gastrectomy is generally the best procedure if the patient's condition warrants; in ulcers of moderate size in the middle third, transgastric resection may give excellent results.

Hour-glass contraction due to ulcer calls for special procedures which we shall not attempt to discuss in this paper.

We have had since 1910, seventy-two cases of gastric ulcer treated by different methods, the results of which we shall not attempt to analyse, as it is a subject deserving detailed study beyond the limits of this paper.

### SUMMARY

1. Surgical treatment of duodenal ulcer should not be resorted to until it is evident that the case is chronic and that medical treatment has failed to give adequate relief or to effect a cure.

2. The operation of choice should be simple gastro-enterostomy without pyloric exclusion. The more radical methods of resection should be reserved for cases with severe hemorrhage; those in which the simpler operations have failed to give relief or cases of gastro-jejunal ulcer.

Gastric ulcers, or cases in which the ulcer has invaded and passed the pylorus into the stomach wall are not considered in this summary.

3. A lasting clinical cure may be expected in at least 80 per cent. to 90 per cent. of cases treated by simple gastro-enterostomy.

# THE PREVENTION OF ACUTE INTESTINAL OBSTRUCTION

## ANALYSIS OF ONE HUNDRED CASES

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THE mortality of acute intestinal obstruction can be reduced only by the early recognition of the condition. Prompt diagnosis and early operation is the only way in which we can hope for a cure. After the toxæmia has spent its force, all else is nil. But the mortality of obstruction is as great to-day as it has been since the beginning of intestinal surgery, despite the progress in abdominal surgery. The toxæmia of the condition is still an unknown quantity in spite of the work that has been done in an attempt to find the cause of the toxic factor.

Most of the literature of this subject is written on the statistics, and the discussion of the toxæmia following the obstruction. Until the cause and the prevention or relief of the toxæmia shall be found, the mortality of the present time will likely continue.

In the ten years between nineteen hundred and thirteen and nineteen hundred and twenty-three, there were approximately one hundred and seven cases of acute intestinal obstruction diagnosed and treated as such at the Maryland University Hospital, by ten different men. From these I obtain the following statistics of importance. This group of cases does not include the strangulated herniæ save one case of strangulated obturator hernia, which was diagnosed as acute ileus following carbon monoxide poisoning.

Of the one hundred and seven cases, there were fifty-six deaths. To include the strangulated hernia of the corresponding time the mortality would be about forty per cent. rather than fifty-two per cent. This closely corresponds to the mortality of eight hundred and forty collected cases of Finney, Deaver, Ross and Flint. In this group I find four cases which were due to bands. There was no history of previous operation, in these cases but each gave a history of having had influenza of the gastro-intestinal type during the epidemic of the year nineteen hundred and eighteen.

The following table presents the location of the obstruction in these cases:

Obstruction in the ileum	68 cases.
Obstruction in the jejunum	19 cases.
Obstruction in the colon	20 cases.
Obstruction due to volvulus in the big gut	1 case.
Obstruction due to volvulus in the small gut	7 cases.
Obstruction due to intussusception in the big gut	1 case.
Obstruction due to intussusception in the small gut	7 cases.
Obstruction due to bands and omentum	23 cases.
Obstruction due to plastic adhesions	38 cases.
Obstruction due to carcinoma of the colon	4 cases.

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Obstruction due to pregnancy	1 case.
Obstruction due to Meckel's diverticulum	4 cases.
Obstruction due to mesenteric cyst	1 case.
Obstruction due to mesenteric thrombosis (arterial)	5 cases.
Obstruction due to mesenteric thrombosis (venous)	1 case.
Obstruction due to tuberculous peritonitis	3 cases.
Obstruction due to foreign bodies	1 case.
Obstruction due to fecal impaction	5 cases.
Obstruction due to bands without previous operation	4 cases.
Obstruction due to obturator hernia	1 case.
Post-operative obstruction	46 cases.
Post-operative obstruction after incision and operation in the lower abdomen	34 cases.
Post-operative obstruction following rectus and midline incision	42 cases.
Post-operative obstruction following McBurney incision for appendicitis	4 cases.
Post-operative obstruction following drained rectus and midline incision	30 cases.
Post-operative obstruction following drained McBurney incision	2 cases.
Number of cases of gut resection.....	12 .....Mortality, 7 cases.
Number of cases of enterostomy.....	16 .....Mortality, 13 cases.
Largest amount of gut resected in any one case,	200 centimetres.

The literature contains many discussions on the proper treatment of acute obstruction both as to resection and enterostomy. This is a matter of choice for the individual operator and the individual case. It is a known fact that death is inevitable after absorption of a certain amount of toxin. The prognosis as Stone quotes may be guarded by the amount of non-protein nitrogen of the blood. Summers and Bonney believe the mortality in the cases of drainage of the gut can be reduced if the enterostomy is done in the jejunum. According to the report of the experiences, the fluid content of the gut is always found in the upper portion of the intestinal tract, while the gaseous matter is found in the ileum and large intestine.

The most impressive thought about the findings of this group of cases is, the question of drainage of the abdominal cavity for conditions other than obstruction *per se*. I believe this abdominal catastrophe might be prevented in a large number of cases by more conservative drainage of the peritoneum.

During the period of time from which this study was made there were approximately four to five thousand abdominal sections performed by various men in this hospital. Of course all cases of post-operative obstruction did not come back to this hospital for treatment, but I believe the statistics collected from the cases we have been able to study, will allow us to conclude to the point of argument, that the abdomen should not be drained though the rectus and midline incision. The rectus and midline incision in these several thousand cases was used about twice as frequently as the McBurney incision. But, in the findings we have forty-two mid-abdominal incisions, of which, thirty were drained, in comparison to four lateral incisions of McBurney, of which, two were drained. Draining the abdomen through the rectus and midline incision gives the coils of intestine a greater possibility of becoming obstructed, because loops of gut may encircle the drain tract, besides leaving at times an organized band free in the peritoneal cavity. In lateral drainage, as in the McBurney



incision where the drain is placed along the pelvic wall, coils of intestine are less likely to encircle the tubes or drain tract. If the peritoneal cavity is likened to a barrel it is better to drain away from the wall rather than drain through the middle of the cavity. The upper abdomen can be drained from the side by instituting drainage through the lateral wall as in the method of gall-bladder drainage of Greenough of Boston. Sub-phrenic abscesses of either side or sub-hepatic abscess can be drained with equal result by this route. Drainage of the lower abdomen is more likely to produce an obstruction because most of the small intestine is situated below the umbilicus, thereby making drainage more difficult.

Therefore in definite cases of acute appendicitis the McBurney incision is of choice, especially where drainage is necessary. We would go so far as to say that it is better to make a stab wound far out to the side where drainage is necessary after operations through the rectus and midline incisions and close the original wound. The time of convalescence would be no greater and the possibility of post-operative obstruction and hernia decreased.

While this is a study of a comparatively small group of cases, we believe it would hold good in a series of a large number of cases, thereby reducing the happening of this condition and reducing the mortality perhaps ten to fifteen per cent.

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## THE TREATMENT OF ACUTE MECHANICAL INTESTINAL OBSTRUCTION BY HIGH TEMPORARY JEJUNOSTOMY\*

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AND

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ACUTE mechanical intestinal obstruction has long been recognized to be a very serious condition accompanied by a high mortality. Even at present, in looking over case histories of this condition, the uniformity with which the diagnosis "acute intestinal obstruction" is followed by "end result, death" becomes very depressing and is a challenge to our ability and skill. For example, in our services in two of the hospitals in this city, within the past two years there have been a total of twelve histories filed under this diagnosis. Of these twelve cases only three recovered. The other nine died at times, varying from during the operation to as late as ten days afterwards. This list, of course, is unselected and comprises cases of all degrees of severity and duration of symptoms; but it is noteworthy that the three who recovered were among these on whom high temporary jejunostomy was performed. Further, all died on whom this procedure was not performed.

Ashhurst in 1890 collected 346 cases with a mortality of 69.3 per cent. The records of St. Thomas' Hospital, London, for the 20 years from 1886 to 1907, shows a total of 543 cases of intestinal obstruction with 319 deaths, a mortality of 58 per cent. Lenormant records his experience in 43 cases in which there were 20 deaths, a mortality of 67 per cent. (Quoted by Guillaume in *Occlusions de l'Intestin*, 1922).<sup>1</sup> Guillaume records 694 cases. Of those in which enterostomy alone was performed, 17½ per cent. died; those in which the operation consisted in release of the obstruction only, 48.2 per cent. died; those in which the operation consisted of release of the obstruction and enterostomy, 24.8 per cent. died. Thus there was the lowest mortality in the first group in which enterostomy alone was performed upon cases presumably offering the greatest surgical risk.

*Pathology.*—It has been shown beyond any doubt in many carefully conducted and brilliant researches, in which the names of Sweet, Draper, and Whipple<sup>2</sup> are so well known, that toxæmia is a constant and important element in intestinal obstruction; that the toxins are generated in the duodenum, probably from the pancreatic and biliary secretions, and that they are of the nature of proteoses. The further the obstruction is below the papilla of Vater the more diluted and harmless the toxins become. Costain<sup>3</sup> has recently shown that the toxic material in intestinal obstruction and also in peritonitis is absorbed largely by the lymphatics; and that dogs with intestinal

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obstruction and a fistula of the thoracic duct live much longer and recover more surely and promptly after the release of the obstruction than control dogs without such a fistula.

*Indications for Treatment.*—The indications for treatment in acute mechanical intestinal obstruction are (1) to remove the highly toxic bowel contents from the body as quickly as possible; (2) to relieve the distention which is paralyzing the intestinal musculature; (3) to restore the continuity of the intestinal lumen and reestablish the fecal current. We consider this to be the order of their importance.

*Methods of Treatment.*—Of the methods of treatment the most obvious is the relief of the mechanical obstruction, whatever its nature, bands, adhesions, volvulus, intussusception, strangulated hernia, or what not. This is sufficient to meet all indications if the patient is seen early—before 24 to 48 hours, while the general condition is still good. But in those distressingly frequent cases where symptoms have been present for a number of days, it is rarely enough. The intestinal muscles have become so paralyzed by distention and by the toxic intestinal contents that they are unable to pass these contents on to the anus rapidly and, therefore, continued absorption occurs. It may be several days before the strangulated segments of bowel, injured by prolonged pressure and anaemia, can recover their tone after a mechanical obstruction has been relieved and thus this mechanical obstruction is frequently succeeded by a paralytic ileus. Thus the simple relief of the mechanical obstruction too frequently fails to meet the prime indication of removing the toxic intestinal contents from the body. This is especially true in cases of long duration.

This insufficiency of mere relief of mechanical obstruction alone has been recognized for many years and various methods have been proposed to solve the problem. In 1908, Gibbon attempted drainage of the toxic intestinal contents by performing a jejunostomy with a Murphy button, and with the happiest primary results; but it was found impossible to permanently close the resulting jejunal fistula and the patient died of inanition. The excision of the strangulated segments with its contents and the subsequent anastomosis of the cut ends of the bowel has been proposed and practiced. This is a heroic procedure and would rarely be possible of accomplishment. Yet this treatment, serious as it is, has distinctly lowered the mortality in a series of cases on which it was tried. (Guillaume<sup>1</sup>.)

Another method is continuous duodenal and jejunal drainage through a duodenal bucket and tube of small calibre. This is often very satisfactory as a temporary measure. It meets the indications very well, as it removes material from the point where it starts to accumulate and where its toxicity is the greatest, namely, the duodenum. It will at times tide over an apparently hopeless patient for a few days until he can undergo an operation with better chances of success. The disadvantage of the duodenal drainage is that it does not expose the pathology to the surgeon; it wastes valuable time if the patient is in condition to stand operation; and during this time the bowel may progress from a condition of strangulation to that of gangrene.

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But there are many cases in which it will prove a life saving measure, and in our hands during the last five years we have felt that it has been a distinct asset in the treatment of intestinal obstruction of all kinds.

The method which we have adopted and recommend is not a new one. It was first proposed by Lennander<sup>4</sup> in 1907. Charles H. Mayo<sup>5</sup> again called attention to this method in 1922, as also did Guillaume.<sup>1</sup> It is simply a rapid high jejunostomy performed after the manner of a Witzel gastrostomy.

*Technic.*—The abdomen is opened and the obstruction released in whatever way seems best; in some cases it will be impossible to take the time either to find, or to reduce the obstruction. A distended coil of intestine is chosen as high in the jejunum as possible, and a good sized soft catheter—about 18 to 22 F.,—with its eye enlarged, is inserted through a hole made in the anti-mesenteric border of the intestinal wall into the lumen and held in place by a purse-string linen suture. The intestinal wall is then folded over the tube and held in place with a single layer of continuous Lembert sutures for a distance of three to four inches; thus the catheter is entirely covered over and buried in the wall of the bowel. The gut is sutured to the peritoneum at the lower angle of the abdominal incision and the abdomen is closed about the tube, and the tube is allowed to drain into a bottle.

*After Treatment.*—No special after treatment is necessary except to keep the tube patent. It sometimes becomes clogged with solid particles but these can be cleared away by irrigation. In one of our cases the bowel angulated at the proximal end of the catheter from lack of muscle tone but this condition was readily overcome by introducing several ounces of fluid through the catheter into the bowel. After the bowels are moving freely, which should happen within forty-eight hours after jejunostomy, and convalescence is established, the tube is removed and the tract allowed to close. We have had no trouble with the failure of the tract to close and do not anticipate any. Several days will elapse before the tube is removed and during this time protective adhesions will have formed which will prevent leakage from the tract into the peritoneal cavity. When the tube is finally removed, from the third to the seventh day, there is left in the intestinal wall a long canal which is lined with endothelium, and which is constantly kept collapsed by intrainstestinal pressure. Very little if any irritating intestinal contents enter this canal after the withdrawal of the catheter and the walls rapidly adhere and coalesce. There is practically no drainage from the time the catheter is removed and the wound has in our experience always healed kindly. We believe that to the use of this procedure two of the subjoined patients owe their lives, while another was brought to a condition where he might have been permanently cured if proper advantage had been taken of the opportunity.

In favor of this procedure we feel that it can be used in any case where operation is possible. There are practically no contra-indications. It is rapid. Alone, it meets the urgent indications but, of course, should be combined with coincident relief of the obstruction if possible. It will, however, sometimes

tide over a patient and improve his condition until a more radical operation can be done, in the same way that the condition of an old prostatic patient will improve after drainage of the bladder has been established by suprapubic cystostomy.

Sir William Taylor<sup>6</sup> gives three classes of cases of acute intestinal obstruction based upon the duration of the symptoms. (1) Under 24 hours, the general condition being favorable, relief of obstruction is all that is required. (2) From 1 to 3 or 4 days, when the general condition is usually fair, there may be stercoraceous vomiting. These patients will usually stand relief of obstruction but jejunostomy as a primary procedure should always be done. (3) Those cases in which the mechanical obstruction has existed for longer than 4 days and in which the general condition is usually poor. Here primary operative interference should be limited to a rapid high jejunostomy. Taylor also advises lavage of the intestines with sodium bicarbonate through the jejunostomy tube. With this classification and recommendation as to operation we thoroughly agree though we have not felt or encountered the necessity for routine intestinal lavage as suggested by Taylor. If we could receive more of our patients in classes 1 and 2 on admission we feel we should not have to confess to a mortality of nearly 75 per cent.

*Illustrative Cases.*—In support of these contentions we wish to refer to the following case abstracts.

CASE I.—M. R., Germantown Hospital No. 3122-1922, No. 2092-1922, a colored woman, age thirty-two years. Duration of mechanical obstructive symptoms, seven days. General condition at time of operation very poor. Pathological condition found:—There was a band of adhesions from the intestines to the scar of a former operative incision, around which a loop of gut had become twisted. Operative procedure—resection of the obstructing band with untwisting of the volvulus. Course—the day after operation the bowels moved three times, then the obstruction gradually recurred and finally became complete. Her general condition slowly declined in spite of duodenal drainage; and eight days after the first operation she was again operated upon and this time her condition was more critical than at the first operation. Second operation—no exploration. A rapid high jejunostomy was done. Course—there was immediate and profuse drainage from the jejunostomy tube and she made an uninterrupted recovery. Her bowels moved twelve hours after the jejunostomy and during the first twenty-four hours she had no less than 12 bowel movements. The tube was removed at the end of the seventh day and the wound was closed at the end of the fourteenth day. This was one of our earliest cases. We feel now that it was a mistake not to have performed a high jejunostomy at the time of the primary operation when the mechanical obstruction was relieved.

CASE II.—Pennsylvania Hospital No. 2493-1923. D. R., an adult colored woman, twenty-eight years of age. Two years before admission she had been operated upon and a bilateral salpingo-oophorectomy was done in another hospital. On admission there were symptoms of complete intestinal obstruction which had been present for five days and her general condition was very unfavorable. Pathological condition found at operation—a loop of bowel was adherent to the right broad ligament, forming a pocket through which another loop of bowel had become strangulated. Operative procedure—exploration, and inspection of the entire intestinal canal. Relief of the obstruction high jejunostomy. During the operation respiration and bleeding from



## JEJUNOSTOMY FOR ACUTE INTESTINAL OBSTRUCTION

the cut surface ceased. Artificial respiration and stimulation were given and the patient responded. Post-operative course—drainage was profuse within several hours after the jejunostomy was performed. Convalescence—the bowels moved the following day. The tube was removed on the fifth day and the wound closed on the twelfth day. Three months after operation, she had an attack of vomiting and some abdominal pain but was not reoperated upon and entirely recovered from these symptoms. Aside from this she has been in excellent health since the last operation.

CASE III.—Pennsylvania Hospital No. 270-1924, P. D., a middle aged white laborer, entered the hospital with symptoms of acute abdominal catastrophe of twenty-four hours duration. General condition at time of operation was poor. Very slow pulse and subnormal temperature. Pathological condition found.—There was gangrene of the entire descending colon starting at the splenic flexure and extending to the rectum. Operative procedure.—A colostomy in the transverse colon was performed after the manner of a jejunostomy. Course.—The general condition was not improved. Drainage was scanty. On the second day the patient pulled out the tube. Immediate reoperation was done and this time a high jejunostomy. Course.—For a number of days his condition improved in a remarkable manner. The drainage was profuse within several hours after performing the jejunostomy. He had an excellent appetite. He had bowel movements from the rectum, first with an enema and then voluntarily. On the eighth day the tube was removed. Following the removal of the tube his condition rapidly grew worse and he died on the tenth day after the primary operation. Autopsy.—The entire gangrenous portion of the colon had sloughed away, and there was a general peritonitis present. Two mistakes were made in the treatment of this case. The first was in making the enterostomy in the transverse colon instead of high in the jejunum; in the second place when the patient's condition had improved so markedly and so unexpectedly, the opportunity of resecting the known gangrenous descending colon was missed; and if this had not been possible, it certainly would have been feasible to have performed a permanent colostomy in the ascending colon proximal to the gangrenous descending colon.

CASE IV.—Germantown Hospital No. 2716-1923. J. Y., a business man, forty-eight years of age, sick for two days with symptoms diagnosed as intestinal obstruction by the surgeon and as acute appendicitis by the physician, Dr. H. B. Wilmer, was operated upon October 27, 1923, and a gangrenous perforated appendix was found in the pelvis. A pelvic peritonitis was present and the abscess was drained. The location of the abscess with adhesions between the cæcum and adjacent coils of small intestines explained the intestinal obstruction which had confused us. He made a fairly good recovery but there was some tendency to distention. On November 6th his duodenum was drained for several days because of vomiting and though this relieved him, unfortunately, at this period he developed signs of a consolidation in the right lung and he passed through a frank lobar pneumonia which resolved by crisis on the sixth day. The cause of the pneumonia was probably a septic pulmonary embolus. On November 22nd he again began to vomit and his bowels failed to move. On the 24th complete intestinal obstruction had developed and a high jejunostomy was done in the middle of the night—no exploration of the abdominal cavity was attempted. The following day the jejunostomy tube was draining freely and he had a bowel movement. On the 26th the tube became clogged and vomiting again occurred. The clogging of the tube at this time we felt was due to an angulation of the paralyzed bowel at the tip of the catheter. The catheter was withdrawn after injecting several ounces of fluid into the bowel and vomiting immediately stopped. After an interval of an hour the catheter was reinserted and drainage reestablished. From this time on there were no more obstructive symptoms. He was discharged convalescent on December 22, 1923, and he has had no symptoms of obstruction at the time of writing, which was four months later. Pathology.—At the first operation, acute gangrenous appendicitis with partial obstruction and pelvic peritonitis. At the second, no exploration was per-

formed on account of the very poor general condition, but part of the intestines were distended and other parts collapsed. The obstruction was doubtless due to adhesions and impaired muscular tone, a result of his pneumonia and prolonged illness. The history of this case is given at some detail because in some respects it is the most remarkable in the series and records a most extraordinary recovery from many complications—three definite attacks of acute mechanical intestinal obstruction.

*Conclusions.*—1. The cause of death in acute mechanical intestinal obstruction is toxæmia from absorption of toxic intestinal contents.

2. The indications for the surgical treatment of acute mechanical intestinal obstruction are in the order of their importance (1) to eliminate the toxic material from the body as rapidly as possible; (2) to relieve the bowel from the distention which paralyzes it; (3) to restore the lumen of the intestines and to reestablish the fecal current.

3. Of the various methods suggested to meet these indications we feel that a high jejunostomy performed with a rubber tube after the technic of a Witzel gastrostomy is the most satisfactory procedure.

4. The procedure should be used, alone or in combination with other procedures, in all cases of acute mechanical intestinal obstruction of over twenty-four hours duration which are submitted to operation.

5. The stoma left on the withdrawal of the rubber tube closes promptly when the need for it has passed.

6. This method when used as a temporary expedient will at times allow an apparently hopeless patient to improve to such an extent that more radical procedures may be attempted later when there is some hope of success.

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## PERFORATED GUNSHOT AND STAB WOUNDS OF THE ABDOMEN

TREATED AT THE GOUVERNEUR HOSPITAL OF NEW YORK

By WOODHULL LEE CONDUCT, M.D.  
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A REVIEW of the records of Gouverneur Hospital of New York City, from March 11, 1911 to August 31, 1922—a period of eleven and one-half years—shows that seventy-nine cases of gunshot and stab wounds of the abdomen were admitted. In this review twenty-seven cases have been excluded because of the lack of evidence of perforation of the peritoneal cavity. Of the remaining fifty-two cases, twenty were gunshot perforations, and thirty-two stab wounds. Of the twenty gunshot wounds there were eleven recoveries and nine deaths, giving a mortality of 45 per cent. and of the stab wounds there were twenty-three recoveries and nine deaths, giving a mortality of 28 per cent. The ages of the patients varied from six to fifty years. There were forty-nine males and three females. The time elapsing from the receipt of injury to the operation varied from one-half to twenty-four hours, with an average of slightly over two hours. The fifty-two cases were operated on by nine different visiting surgeons.

CASE I.—March 26, 1911. J. M., male, Italian, thirty-eight years, laborer. Patient was shot in the abdomen and operated on two hours after admission to hospital. When the peritoneal cavity was opened, there was a large amount of fluid and clotted blood. There were three perforations through the ileum and jejunum, a perforation of the mesentery and a bruising of the transverse colon. This case died four hours after admission of shock and hemorrhage. Autopsy showed no further hemorrhage or leakage through the suture line.

CASE II.—May 2, 1911. N. S., male, Russian, nineteen years, newsboy. This boy was stabbed in the abdomen and operated on seven hours after the injury. An incision was made through the wound and protruding omentum returned. Exploration showed the viscera uninjured. Recovery.

CASE III.—June 29, 1911. W. C., U. S., twenty-three, male, driver. Laparotomy was done one hour and fifteen minutes after a gunshot wound, but no viscera were found injured, with the exception of a small contusion of the serous coat of the small intestine. Cured.

CASE IV.—January 25, 1912. Name, nativity, race, unknown. Male. Gunshot wound of the abdomen, no operation performed, died one-half hour after admission to hospital from shock and hemorrhage. No autopsy.

CASE V.—March 10, 1912. D. M., Irish, forty, male, occupation unknown. Patient was admitted to hospital two hours after a gunshot injury and exploration showed one perforation of the omentum with no other visceral injury. Drainage. Recovery.

CASE VI.—June 16, 1912. H. W., nativity, and occupation unknown, fifty years, male. Operation showed two perforations of the cardiac end of the stomach, a long wound of the liver, running from the right to the left lobe. Death within eighteen hours due to shock and hemorrhage. Autopsy showed both lungs collapsed with a hæmopneumothorax.

CASE VII.—August 2, 1912. B. G., U. S., twenty-two, male, salesman. Admitted

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to hospital after a gunshot wound of the abdomen, lung and right thigh. At operation a large laceration of the liver was found. Liver wound packed. Recovery.

CASE VIII.—February 20, 1913. I. L., Russian, thirty-five, male, sailor. Admitted to hospital after a stab wound of the abdomen, with omentum protruding, and some intestine. Operated on one-half hour after admission. Patient had a complete evisceration and died on the ninth day of general peritonitis. No autopsy.

CASE IX.—May 14, 1913. J. K., U. S., twenty-nine, male, laborer. Operated on one-half hour after admission for gunshot wound. At operation there were two bullet wounds of the stomach, and one perforation of the liver and pancreas. Died on fourth day apparently of peritonitis. No autopsy.

CASE X.—June 1, 1913. T. A., Russian, forty-eight, male, laborer. Stab wound with omentum protruding. Operated on under spinal anaesthesia. No visceral injury found. Recovery.

CASE XI.—August 9, 1913. T. S., Italian, thirty-four, male, laborer. Gunshot wound of the abdomen. Operated on three hours after injury, two small perforations of the small intestine and rupture of the spleen, suture of the intestines and splenectomy, drainage. Recovery.

CASE XII.—August 15, 1913. M. B., U. S., twenty-two, male, printer. Stab wound of the abdomen with small intestine protruding and laceration of the arm. No visceral injury, drainage. Recovery.

CASE XIII.—August 31, 1913. F. C., Italian, nineteen, male. Gunshot wound of the abdomen, operated on soon after admission two perforations in the lower end of ileum, opposite each other necessitating an 8 inch resection with an end-to-end anastomosis and drainage. On the fourth day operated on for intestinal obstruction and a perforated bowel found. Sixth day, death from general peritonitis. No autopsy.

CASE XIV.—October 13, 1913. E. L., Italian, twenty-one, male. Stab wound of the abdomen. Operated on shortly after admission and stab wound of the liver closed with mattress suture of silk, drainage, death. No autopsy.

CASE XV.—May 1, 1914. A. K., Russian, thirty-four, male, special officer. Stab wound. No operation done, recovery. Pathology unknown.

CASE XVI.—August 27, 1914. J. L., U. S., twenty-nine, male, machinist. Operated on five hours after a stab wound of the abdomen with a piece of omentum protruding. Because of acute alcoholism this case was done under local anaesthesia. Death on fourth day. No autopsy.

CASE XVII.—December 5, 1914. M. S., Russian, fourteen, male, school boy. Stab wound of the abdomen, operated on three and a half hours after admission, omentum protruding, small amount of hemorrhage with a small hole in the stomach. Recovery.

CASE XVIII.—September 15, 1915. J. C., Irish, thirty-four, male, driver. Stab wound operated on one hour later, protruding omentum no viscera injured. Complications, stab wounds of chest and arm. Death on fourth day from peritonitis, no autopsy.

CASE XIX.—October 6, 1915. F. D., Italian, thirty, male, laborer. Stab wound with omentum protruding operated on fifty minutes later, no visceral injury.

CASE XX.—January 18, 1915. M. P., Russian, twenty-one, male, tailor. Suicide. Gunshot wound of the abdomen, operated on three hours later, two holes in stomach, one in the colon, and a large rent in the mesentery with a wound of the kidney. This case is of special interest as there was only one kidney of the horseshoe type. On the eighth day he was given solid food by his relatives, death on the ninth day from embolism. No autopsy.

CASE XXI.—April 23, 1915. L. M., Italian, thirty, male, operator. Gunshot wound of right arm and leg and abdomen. At operation shortly after admission there were eight perforations of the intestine, necessitating a six inch resection in which five perforations were found. Almost complete obstruction followed and frequent lavage

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was done. On the forty-first day the Murphy button which was used in the suture was removed. Recovery.

CASE XXII.—January 19, 1916. S. S., Russian, twenty-seven, male, presser. Stab wound of the abdomen with omentum protruding, operated on two hours after admission, no visceral injury. Died immediately after operation. No autopsy.

CASE XXIII.—January 1, 1917. A. H., U. S., twenty-two, male. Gunshot wound of the abdomen, laparotomy soon after admission, two perforations through ileum and mesentery, general peritonitis, suture, drainage. Recovery.

CASE XXIV.—March 14, 1917. A. V., Italian, thirty-one, male, operator. Multiple stab wounds of head, face and abdomen. Three-quarter inch laceration of anterior wall of stomach, sutured, drainage. Recovery.

CASE XXV.—April 8, 1917. A. B., Italian, twenty-four, male, chauffeur. Operated on for stab wound of the abdomen six hours after injury. Laceration of omentum, no visceral injury, drainage. Recovery.

CASE XXVI.—July 4, 1917. F. T., Italian, nineteen, female, operator. Fell off a chair onto scissors which perforated the abdomen. At operation one hour after admission there was a lacerated wound of the ileum, colon and the inferior vena cava. The abdomen was full of blood, suture of vena cava, with linen purse-string and closure of the intestine. Recovery.

CASE XXVII.—August 22, 1917. F. V., Italian, sixteen, male, clerk. Stabbed in abdomen twenty-four hours before operation. There was a perforation found in the gall-bladder and common bile duct. No attempt at suture was made, drainage. Recovery.

CASE XXVIII.—June 2, 1918. Italian, male. Stab wound of abdomen, operated on soon after admission, perforation of transverse colon with fecal matter in the abdomen. Suture, drainage. Death. No autopsy.

CASE XXIX.—September 6, 1919. E. W., Austrian, twenty-four, male, milliner. Stab wound of the abdomen, operated on three and a half hours after injury, small blood-vessel severed, no visceral injury, drainage. Recovery.

CASE XXX.—September 21, 1918. J. G., German, forty-four, male, kitchen man. Laceration of scalp, lip, tongue and stab wound of the abdomen with omentum protruding. Operated on three and a half hours after injury. Laceration anterior wall of stomach near cardia. Suture, drainage. Death on fifth day. Peritonitis. No autopsy.

CASE XXXI.—April 27, 1919. A. S., Italian, thirty-one, male, barber. Stab wound of the abdomen. Operated on soon after admission, rupture of the liver. Packed, drained. Recovery.

CASE XXXII.—August 17, 1919. J. M., Italian, twenty-one, male, laborer. Operated on six hours after a stab wound, laceration of omentum, no visceral injury, suture of omentum, drainage. Recovery.

CASE XXXIII.—December 3, 1919. M. J., Russian, eighteen, female. Bullet wound of liver, into right lobe, operated on one hour after admission, packed, drainage. Complications, pneumonia. Double suppurative otitis media. Recovery.

CASE XXXIV.—February 20, 1920. J. D., Irish, thirty-two, male, laborer. Gunshot wound of the liver operated on one hour later, packing, drainage. Recovery.

CASE XXXV.—April 17, 1920. S. K., U. S., twelve, male, school boy. Gunshot wound of liver and kidney, right lumbar nephrectomy, drainage, packing. Death ten hours later from hemorrhage. No autopsy.

CASE XXXVI.—June 29, 1920. H. L., Austrian, twenty-four, male, laborer. Stab wound of liver. Operated on one hour later. Suture of liver, drainage. Recovery.

CASE XXXVII.—July 26, 1920. T. K., Russian, twenty-seven, male, longshoreman. Operated on two hours after a gunshot wound in abdomen, seven perforations of small intestine. Enterorrhaphy. Drainage. Recovery.

CASE XXXVIII.—July 27, 1920. J. G., Irish, thirty, male, laborer. Gunshot wound of liver, two hours after, suture of liver, complicated by fracture of rib and severe hemorrhage. Died within forty-eight hours. No autopsy.



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CASE XXXIX.—December 13, 1920. M. S., Russian, thirty-five, male, laborer. Stab wound of abdomen, omentum protruding. Operation one and one-half hours after injury, perforation of stomach, suture, six weeks later secondary closure. Recovery.

CASE XL.—December 28, 1920. S. K., U. S., eight, male, school boy. Stab wound of abdomen. Operated on three hours after injury, perforation of stomach and omentum. Suture, drainage. Recovery.

CASE XLI.—April 13, 1921. J. J., Russian, twenty-nine, male, laborer. Stab wound of left lobe of liver. Operated upon soon after injury, suture, drainage. Recovery.

CASE XLII.—May 24, 1921. J. B., Russian, thirty-eight, male, peddler. Stab wound, operation two hours later, omentum protruding, no visceral injury, complication pneumonia. Recovery.

CASE XLIII.—June 14, 1921. I. F., U. S., twenty, male, peddler. Stab wound of stomach, two hours later repair, drainage. Recovery.

CASE XLIV.—August 18, 1921. L. L., Roumanian, twenty-three, male, student. Stab wound of the stomach, perforation of anterior wall of stomach. Suture. General peritonitis. Death on fourth day. No autopsy.

CASE XLV.—August 25, 1921. P. K., U. S., thirty-seven, male, chauffeur. Stab wound of spleen, drainage, no suture. Recovery.

CASE XLVI.—August 28, 1921. S. N., Polish, thirty-six, male, sailor. Stab wound of left chest, wrist, thigh and abdomen, omentum protruding, no visceral injury, drainage. Recovery.

CASE XLVII.—May 31, 1920. G. M., Irish, thirty-one, male. Stab wound of abdomen, with division of epigastric vessels, negative for visceral injury. Drainage. Recovery.

CASE XLVIII.—November 21, 1921. H. G., U. S., thirty-nine, male, jobber. One hour and a half after stab wound, five perforations of jejunum, perforation of transverse colon, perforation of mesentery, fifty-four inch resection of jejunum with end-to-end anastomosis with Murphy button. Recovery.

CASE XLIX.—January 16, 1922. A. D., Russian, twenty-four, male, seamen. Gunshot wound of abdomen, immediately after operation. Laceration of liver, and right kidney. Suture of liver. Right nephrectomy, counter stab wound for drainage. Recovery.

CASE L.—January 17, 1922. U. S., six, female, school girl. Gunshot wound of abdomen, one hour after injury, ten perforations were found in the ileum and three feet of intestine resected. Died twelve hours after operation of shock, no autopsy.

CASE LI.—March 11, 1922. M. C., twenty-one, male, bullet wound of abdomen. One hour after injury, double perforation of sigmoid, two double perforations of ileum, and perforation of jejunum. Eight inch resection of ileum, end-to-end anastomosis, five inches from the ligament of Treitz. Drainage. Recovery.

CASE LII.—August 13, 1922. W. W., thirty-five, male, barber. Stab wound of abdomen and chest near the heart. Two hours after injury operation. Small intestine protruding, mesentery lacerated, mesentery sutured, drainage, complication pleurisy, following pneumonia, and death on the fourth day. No autopsy.

Reference to the literature on the subject reveals a large number of articles from various hospitals and numerous reports from military surgeons on the field of battle and emergency hospitals behind the lines. During the Civil War the mortality was 90 per cent. In the Boer War about 40 per cent. without operation. This may be explained by the existence of only one or more small perforations with a bowel fairly empty as often seen in a soldier in the field. Fenner in the *ANNALS OF SURGERY*, 1902, reports 152 cases from the Charity Hospital in New Orleans, of which 96 were gunshot wounds with visceral injury. Of these 71 died; a mortality of 74 per cent.

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Winslow reports 31 cases of stab and gunshot wounds over a period of five years seven months in the *Surgery, Gynecology and Obstetrics*, May, 1922, taken from the University Hospital in Baltimore; in these cases the mortality was just under 50 per cent., in the stab cases it was 25 per cent. and in the gunshot wounds 50.5 per cent.

In summing up the Gouverneur Hospital Series the mesentery was perforated four times, the omentum five times and the inferior vena cava once. Omentum was found protruding from the abdomen five times and the intestine three times. Of the wounds of the hollow organs there was one of the gall-bladder and common bile duct, ten of the stomach, two of the descending colon, two of the transverse colon and one of the sigmoid, six of the jejunum and six of the ileum.

Of the solid organs there was one perforation of the pancreas, only two perforations of the spleen, three of the kidney and twelve of the liver. In no case, in this series, were the pelvic organs or the bladder involved. In only one instance in the series was a perforation overlooked at operation and found at autopsy and this case was an exceedingly difficult one—inasmuch as five other perforations were found.

In the last twenty-five years, or since the time of the Spanish-American War, but little advance has been made towards lowering the mortality in gunshot and stab wounds of the abdomen. All surgeons are agreed that immediate operation following injury offers the best results, although from time to time, as in one case of this series, recoveries have taken place without operation.

In an article appearing in the *ANNALS OF SURGERY*, issue of September, 1923, by Mason of Birmingham, Ala., in analyzing sixty-nine cases of "The influence of Hemorrhage on Mortality in Gunshot wounds and other injuries of the Abdomen," he lays great stress upon the feature of hemorrhage, and classifies his cases into a large hemorrhage series, with a mortality of 88.8 per cent. against a small hemorrhage series with a mortality of 31.5 per cent. He urges a more extensive employment of transfusion and suggests that auto-transfusion should be practiced in selected cases.

Certainly these perforated gunshot and stab wounds of the abdomen have furnished considerable food for thought to the surgical profession in the past and will continue to do so in the future. Possibly local anæsthesia would be a factor in lowering pulmonary complications. Since it is impossible to tell just what damage an instrument penetrating the abdominal wall has done, immediate laparotomy offers the greatest chance to the patient with a complete evisceration and thorough examination of all organs.

## APPENDICEAL FECAL FISTULA\*

BY JOHN B. DEAVER, M.D.

OF PHILADELPHIA, PA.

APPENDICEAL fecal fistula is one of our more or less constant companions in the Lankenau Clinic, and no doubt also in other hospitals, where a great many operations for acute appendicitis are performed. Pathologically speaking, the present classification of appendicitis may be correct, but for clinical purposes it is too complicated, and what is more important, it is not practical, since these distinctions cannot be made at the bedside with any certainty. In the Lankenau Clinic we make the general classification of chronic and acute appendicitis since we find that practically all cases of acute appendicitis are partially or entirely gangrenous. That is to say, when the acute appendix is laid open the mucosa will be seen to present gangrenous areas or to be gangrenous throughout while often the entire appendix is gangrenous. Where the gangrenous area is large or involves most, if not all, of the mucosa, it is not uncommon for the patient to have a severe chill associated with the other familiar symptoms. I am frequently asked what is the significance of a chill in appendicitis; the foregoing is the answer. A chill may also be due to a thrombophlebitis of the veins of the mesoappendix and of those into which they empty. The late Dr. A. G. Gerster called attention to the possibility of a purulent pyelophlebitis the result of appendicitis, when he remarked that the occurrence of a chill is of the greatest import, and should be considered to constitute a more urgent indication for operation than even the signs of local peritonitis. I am also frequently asked why some cases of acute appendicitis have pain in the left side. The answer is that the appendix in such cases occupies the pelvis or lies beneath the terminal mesentery and points upward and to the left. It may be interesting to consider the different positions in which the appendix is apt to be located. The two most common positions are retrocaecal and retrocolic, when it frequently extends as high up as the gall-bladder, and the pelvic or descending position; other positions in the order of frequency are: Subcaecal, anterior to the terminal ileum, or pre-ileal and posterior to the terminal post-ileal or splenic, pointing in the direction of the spleen.

The complication of appendicitis by fecal fistula is one peculiarly confined to the case presenting perforation, abscess and drainage. The last 200 cases of appendiceal fecal fistula in the Lankenau Clinic occurred among a series of 4063 cases of acute appendicitis, an incidence of approximately five per cent. In every instance more or less pus was present at the primary operation and required drainage either with gauze, cigarette drains or glass tubes. In the vast majority of cases some ulceration of the caecum or terminal ileum was noted at the primary operation. The cases which showed perforation at the base of the

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appendix displayed a peculiar tendency to the formation of a fecal fistula owing to the amount of inflammatory reaction and the friability of the tissues which must be relied upon for turning in the stump.

Of the 200 fistulas 74, or 37 per cent., healed spontaneously, while 97, or 48.5 per cent., required operative repair. The remainder, 29, or 14.5 per cent., left the hospital, having refused operation, or were sent home to recuperate, and to return later for operation, but failed to do so. No doubt a certain proportion of these latter closed spontaneously later on and can therefore be included among that number.

The longest duration of fecal drainage before operative relief was sought was in a patient who had had an intermittent discharge for seven years; while the shortest duration of the fistula was a case which closed spontaneously in twelve hours. As a rule, a period of trial for possible spontaneous closure was permitted to pass, before deciding to operate, the length of time depending upon the general physical condition, the amount and character of the drainage, and the mental attitude of the patient.

The type of operation for repair of the fistula depended, of course, upon the conditions existent at the time. In 60 per cent. of the cases, simple inversion of the fistulous opening by a purse-string linen suture, reinforced by an additional suture line, was all the surgery required. In 15 per cent. the condition of the bowel surrounding the fistula was such as to excite doubt as to its regenerative power in the presence of the usual fecal stream, so that an ileocolostomy was performed to short-circuit the affected bowel, after inversion and reinforcement of the fistula. The site of the anastomosis was usually from a convenient point near the terminal ileum to the transverse colon. Twenty-three per cent. of the cases presented either multiple fistulas or else the fistula was so large as to preclude closure with maintenance of the lumen of the bowel surrounding the fistula, so that hope for the recovery of this portion of the bowel had to be abandoned. These required resection of the bowel, varying from a small portion of the cæcum to resection of a foot or more of the terminal ileum with the cæcum and entire ascending colon. Ileocolostomy was of course the last stage of the operation.

Eighty of the 97 operated cases recovered and were discharged perfectly healed. In eight instances there was a recurrence of fistula, while nine cases died after operation, from shock, cardiac failure or other causes.

Nature alone then was able to heal 37 per cent. of cases, but in nearly 50 per cent. she needed the timely aid of the scalpel and the needle, after which 80 per cent. of these latter joined the ranks of the sound in body, having successfully turned back the insidious attacks of the insidious appendix.

I have to thank Dr. Maurice P. Charnock, one of my senior surgeons in the Lankenau Hospital, for collecting the data which made this discussion possible.

## FURTHER STUDY OF CYSTS OF THE SPLEEN

BY ROYALE H. FOWLER, M.D.

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THE first study, by the writer entitled "Non-parasitic Cysts of the Spleen", was published in 1910, a second appeared in 1913 (*ANNALS OF SURGERY*, vol. lvii, p. 658) and a third article "Surgery of Cysts of the Spleen" followed in 1921, (*ANNALS OF SURGERY*, vol. lxxiv, p. 20). In these contributions all cases appearing in the literature were collected and reviewed. Especial attention was given to nosology, pathogenesis, pathology and surgical treatment. An intensive effort was directed toward cornering the knowledge of these phrases.

The writer's review up to December 31, 1921, is summarized as follows: 1. There are two cases of dermoid cysts reported. 2. There are ninety recorded cases of non-parasitic cysts of the spleen which represent a variety of types due to various causes. Non-parasitic cysts are most common in women during the child-bearing period. Pregnancy and antecedent disease of the spleen can be evoked for minor contributing rôles. Trauma plays the most important rôle in the single, large unilocular so-called hemorrhagic or serous types; the latter may develop from the former by liquefaction of solid contents or the hemorrhagic types may be caused by the occurrence of secondary hemorrhage into the serous variety. The influence of a twisted pedicle, embolism and disease of intrasplenic blood-vessels cannot be denied. In the case of multiple cysts, inclusions of misplaced cellular nests (endothelium of the peritoneum or cells of origin of lymphatic spaces or vessels), during the developmental period or as a result in later life, of traumatic or spontaneous rupture of the capsule or of perisplenitis, may result in multiple cysts of the serous or lymphatic variety. Fifty-eight cases of non-parasitic cysts have been treated surgically, eight by puncture, fourteen by incision and drainage, six by excision or partial splenectomy and thirty by splenectomy. The latter is usually the method of choice. 3. Echinococcus cysts occur in two forms single and multiple; solitary cysts are rare. The combined statistics of Thomas, Mosler, Fehleissen, Coen and Tinkler indicate a possible total of 191 cases of parasitic cysts up to 1894. Johnston collected from Bessel-Hagen's series 15 splenectomized cases of hydatid disease up to 1900 with four deaths. He added 8 additional cases with no deaths. The mortality for these 23 splenectomized cases is about 17 per cent. According to Finklestein there have been 46 cases of echinococcus cysts subjected to splenectomy up to 1909, with eight deaths to which may be added two cases of Sherren and Hitzrot (unpublished) without mortality. The operative death rate for 48 splenectomized cases is about 15 per cent. 4. True neo-formative cysts (lymphangioma, hæmangioma) are not common.



## CYSTS OF THE SPLEEN

*Non-parasitic Cysts.*—Morphologically these can be divided into two main groups which are of especial clinical interest. 1. Single with serous or bloody contents, usually large. A large number in this group are more properly designated encysted hæmatoma and are of traumatic origin. 2. Multiple, fused and of varied origin still undetermined. These may be designated polycystic disease (Coenen-Fowler).

The classification based on pathogenesis submitted by the writer in 1921 has received favorable comment, but it is felt that much is still to be desired. It is believed that the following classification is rather more inclusive and will further improve our understanding.

1. Traumatic cysts.

(a) Usually large and unilocular, occurring as encysted hæmatoma, contents hemorrhagic or serous. (This is by far the most common variety.)

(b) Usually small, superficial or deep-multiple, arising from inclusions of peritoneum. (Rare).

2. Inflammatory cysts.

(a) Tuberculous cysts. (Charles H. Peck).

(b) Snared off endothelium usually superficially buried in the spleen as the result of perisplenitis (small and multiple). Due to malaria, leishmaniasis, etc.

3. Degeneration cysts. (Solitary and large). Arising from secondary changes in infarcted areas from arterial degeneration or occlusion of blood-vessels by emboli with consequent necrosis of the pulp.

4. Dilatation cysts. Ectasis of splenic sinuses. (Polycystic disease Coenen-Fowler). These are multiple, fused and cysts usually riddle the organ.

5. Neoplastic types. (Lymphangioma, hæmangioma). It may not be possible to distinguish Group 4 which may be borderline in its tendencies from this group. The differential criterion is still obscure.

From January 1, 1922, a number of cases have been brought to light. The following case hitherto unmentioned was discovered during a visit to the Warren Museum, Harvard Medical College. The curator kindly supplied the following:

Specimen No. 8585. Cystic spleen. Male, age forty, died suddenly probably from apoplexy. The organ was considerably enlarged and the substance partly replaced by numerous thin-walled cysts. Contents coagulated on hardening. Cavities communicated by small openings and are probably in relation to the lymphatic system. This was an autopsy specimen, and may be included under the caption polycystic disease.

Egon Ewald describes two cases. One was a serous cysts, the size of a child's head, situated at the lower pole. Pre-operative diagnosis, ovarian cyst. The second was also a large, solitary blood-cyst which was surrounded by scanty remains of splenic tissue. Splenectomy was performed in both with recovery.

Lombard and Duboucher report a case of encysted hæmatoma without a distinct wall. The development of the clinical tumor was coincident with a severe attack of malaria, but the cyst was considered to be an old process. The contents were pure blood in various stages of disintegration. Because of dense adhesions subcapsular splenectomy

was successfully performed without bleeding after ligation of the pedicle. These authors in addition to 41 cases of this kind assembled by the writer, have collected 17 others.

Harnett has also reported a traumatic encysted hæmatoma. Three years intervened between the injury and the occurrence of malaria which caused swelling, pain and fever sufficient to warrant splenectomy. Convalescence was uneventful. It is recalled that Harnett reported a similar case in 1907 (previously incorporated in my series) of a large cyst full of altered blood due to spontaneous rupture of a syphilitic intrasplenic aneurism. Wassermann reaction was negative in his recent case.

Costanini also reports a cyst with bloody contents in a malarial spleen adherent to the diaphragm. The outer wall was formed by the splenic capsule and he believes the adhesion caused the splenic pulp to separate and to result in hemorrhage. Successful splenectomy after preliminary pedicle ligation. This was followed, however, by a violent outburst of malaria.

Charles H. Peck reported a case of tuberculous cyst before the Southern Surgical Association, December 11, 1923. Details of this case are not available at this writing.

More recently Gosselin has reported a case of degeneration cyst, which all but involved the entire spleen and contained altered blood. There was a history of malaria twenty-eight years previously. Splenectomy was successfully performed by Samson. There was no injury. Factors considered in the mode of origin were pregnancy and possible embolism twenty-four years previously or selective vascular degeneration evidenced by high blood pressure with consequent spontaneous rupture of an intrasplenic blood-vessel. (No evidence of lues). Almost complete obliteration of a large branch of the splenic artery was present which suggested that a kinking had occurred, possibly induced by pressure of an enlarged spleen. A developmental anomaly of this branch was suggested as a contributing cause simulating the tortuous course of the main vessel.

In all, 36 cases of non-paracystic cysts have been treated by splenectomy, the result is unstated in two cases. In 34 cases one death occurred. Mortality of about 2 per cent.

*Echinococcus Cysts.*—The elongated shape of the spleen has been said to be characteristic of the disease. Michaelson believes this results because of the predilection for the centre of the organ, causing the poles to be separated by growth of the cysts. Hitzrot's specimen assumed this shape. Emphasis is laid upon the development of toxic symptoms from dissemination of echinococcus fluid. These are said to be due to anaphylaxis. Fuster and Godlewski observed such symptoms five days after drainage. Tapping is dangerous and should not be used even as preliminary to splenectomy unless due protection is afforded the peritoneal cavity. Transplants may occur in the abdominal wall, but in spite of this warning, this feature is brushed aside by Cignozzi who advocates splenostomy as the treatment of choice for the reason that in his experience adhesions have generally interfered with the performance of splenectomy. A persistent fistula has resulted in some from marsupialization (Solieri, Heurtaux) others have been successful. (Huntington). Cignozzi found hydatid cysts in the spleen in 4 of his 62 cases of echinococcus disease, while the liver was involved in 44. The cysts in the spleen had a capacity of from 200 to 600 c.c. and the outline of the spleen was characteristic. The general health was good, but albumin and casts were found in the urine. The latter disappeared in from four to six days after operation. Cignozzi stresses the necessity for later plastic repair of the

## CYSTS OF THE SPLEEN

breach in the abdominal wall. He considers the secret of success lies in making a very wide opening in the cyst and maintaining an ample external opening from the outset. He believes it to be of the utmost importance to make the incision in the cyst wall as extensive as possible, to the end that there may be a correspondence between the dimensions of the cyst and of the splenostomy opening. The cystic cavity is completely filled with sterile gauze which is changed after 48 hours and then daily for 8 to 10 days. No irrigation of the cavity is practiced. Packing must be continued conscientiously for 3 to 5 months.

Lubbers and Nordenbos report a fatal case following splenectomy and discuss cases reported especially in the Dutch literature. These authors are of the opinion that the so-called "descending types" lend themselves more favorably to splenectomy than the ascending ones.

Martelli has reported three cases of echinococcus cysts and believes diagnostic signs are to be found in the blood and in the urine. Eosinophilia reached four times the normal. Two of the cases exhibited albuminuria which disappeared after operation. Martelli also recommends Marsupialization "à capitonage."

H. W. Mills has recently reported four cases of hydatid cysts of the spleen. This author states that but twelve other cases have previously been reported in the literature of North America. (Nine cases reported by Lyon up to July 1, 1901, and three cases subsequently by Cahana, Jones and Edleman). This author reports a total of fifty-six cases subjected to splenectomy with a mortality of 14.3 per cent.

## CO-EXISTENT NEPHROLITHIASIS AND URETEROLITHIASIS ON OPPOSITE SIDES

By W. FRANK FOWLER, M.D.  
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THE simultaneous lodgement of a stone in one kidney and another in the opposite ureter is sufficiently unusual to merit discussion, particularly concerning treatment.

The subject was strikingly brought to my attention by the case of a boy nineteen years old. This patient was seen first at his home after a severe attack of pain in the lower right side and back had driven him from his work to his bed. He was pale and thin. The abdomen was somewhat retracted and slightly rigid in the lower right quadrant. There was some tenderness on deep pressure in the appendix region. The temperature was normal. During the previous evening and night spasmodic pain had occurred at intervals in the right side and back. The patient vomited several times and had eaten nothing since the beginning of the attack. After removal to the hospital the leucocyte count was 15,600 and the polymorphonuclears 83 per cent. The temperature had risen to  $101\frac{1}{8}$ ° F. The urine was loaded with pus and the roentgenogram revealed two dense shadows, one deep in the pelvis in the region of the right ureter near the bladder, the other apparently in the lower pole of the left kidney (Fig. 1). Preliminary cystoscopy by Doctor Waterman showed oedema and swelling of the right ureteral orifice. The catheter would not enter. The indigo-carmin solution was not excreted from the right side. There was total excretion from the left side in eight minutes.

The significance of the early history became manifest, as frequently happens, after the diagnosis had been established by the urinalysis, roentgenograms and cystoscopy. During early infancy, for example, the child often danced and screamed before voiding. The X-ray examination a few years later, however, was negative. No cause for the pain was discovered, but the attacks became less frequent. During the past few years dull pain, usually of short duration, recurred at intervals of several weeks or months, sometimes with vomiting. There was no nocturnal voiding. The attacks were not incapacitating.

At operation on September 23, 1923, a smooth oval calculus which was impacted in the lower right ureter was removed through the extraperitoneal incision of Gibson. The temperature, which rapidly rose on the day of admission to  $103\frac{1}{8}$ ° F., became  $104\frac{1}{8}$ ° F. on the following day soon after the operation and gradually declined to normal at the end of a week. A smear on the tenth post-operative day from the left ureteral urine showed many pus cells and Gram-negative bacilli but the urine from the right (operated) side contained merely moderate numbers of pus and red cells and no organisms. The cultures, however, from both sides developed Gram-negative coliform bacilli. Cystoscopy on the tenth post-operative day revealed considerable swelling and oedema about the meatus of the right ureter, but the catheter could be passed to the kidney pelvis. The urine from the left side was very cloudy, that from the right bloody, probably due to trauma. The phthalein excretion from the right side was 10 per cent. 20 minutes after intravenous injection. The left side excreted 30 per cent. 20 minutes after the injection. Operation on the left side not advisable because of the low excretion. Cystoscopy on readmission January 4, 1924, showed much flocculent pus in the bladder. The left meatus was somewhat inflamed and considerable purulent urine flowed from it. The right side appeared normal. The indigo-carmin was excreted in good quantity from both sides, probably a little more from the right. There was marked improvement in function since the previous examination.

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At operation on January 5, 1924, a branched calculus in the lower pole of the left kidney was readily palpated through the overlying, thinned parenchyma. Apparently the thinning was due to pressure atrophy without necrosis. This stone was removed from the lower calyx in which it was firmly impacted through an incision in the pelvis. Another stone the size and shape of a cucumber seed was located and removed digitally from the middle calyx in which it was lying free. The pelvis and calyces were moderately dilated, but there were no gross evidences of renal infection. The smaller stone which was not revealed by the X-ray examination prior to the first operation may possibly have formed in the interim. A febrile reaction similar to, but less severe than that which followed the ureterolithotomy, ensued.

Regarding frequency Braasch observes that among 450 patients who were operated on for nephrolithiasis the bilateral occurrence of stone was noted in 48 instances, and in only 3 cases was the stone found in the kidney on one side and in the ureter on the other. The shapes assumed by calculi, according to Keyser and Braasch, apparently depend chiefly upon the site of the development of the stone. For example, small calculi lying in the minor calices usually have the contour of the calyx and larger "stag horn" stones may follow the pelvic outline. The "Jack stone and mulberry" forms, however, are not readily explained on such a basis.

The branched stone in my case appeared upon X-ray examination to be without doubt a single calculus, but Braasch reminds us that the merged shadows of partially superimposed concretions often simulate a single branched stone. Barney, also, observes that one large X-ray shadow may obscure other smaller shadows lying in front of or behind it and lead to the removal of but one stone without further search. And Braasch states that multiple stones are often removed from the kidney at operation after the roentgenogram had exhibited only one shadow. Furthermore, Mayo warns us that shadows apparently due to calculi in the right kidney may be cast



FIG. 1.—Röntgenogram showing one calculus in the lower right ureter and another in the lower pole of the left kidney.



by stones in the gall-bladder, although gall-stone shadows usually may be identified by their concentric layers and density. In spite of the reliability of the X-ray, Braasch writes that "interpretation of the röntgenogram without complete clinical and cystoscopic data is inaccurate and operation based upon such evidence alone is not good surgery."

Many expedients have been employed to the end that stones might not be overlooked at operation. Barney, for example, suggests flushing the kidney pelvis in order to dislodge and wash out small calculi. Barney also advocates the old-fashioned method of needling the kidney, preferably with the rounded end of a small flexible probe. Mayo, on the other hand, favors digital examination of the kidney pelvis and deprecates the practice of needling. More recently the use of the fluoroscope at operation has reduced to a minimum the likelihood of overlooking calculi. Barney has adopted an X-ray check-up for overlooked stone before the patient leaves the hospital with a view to performing a second operation if necessary ten days to two weeks after the first, unless contra-indications exist.

My patient exhibited, during a period of several years, attacks of pain which were not severe enough to call attention to his urinary tract. Fortunately, however, the impacted stone in the left kidney remained relatively small and the organ suffered little damage. Braasch reports that in a series of 484 operations for nephrolithiasis, 204 nephrectomies were done. In most instances removal of the kidney was necessitated by pyonephrosis and stone. In many of these cases symptoms had existed for many years and the condition was either unrecognized or had remained dormant. Braasch observes, also, that the large proportion of multiple stones (188) may be due partly to the fact that most of the patients of this group had experienced symptoms for a long time. It is evident that the formation of the stones and the destruction of the kidney could be largely prevented by early operation. Possibly the symptoms mentioned by Braasch bulked larger in retrospect than they did during the slow process of stone formation and accretion and of kidney infection and destruction. However, Ochsner and ~~Sanes~~ <sup>Sanes</sup> emphasize the importance of careful history taking. Beyond question many of us rely too much upon laboratory findings and too little upon personal observation.

Regarding the differential diagnosis, the errors made when the stone is on the right side are perfectly familiar. However, the statement of Braasch is illuminating that 21 patients with stone in the left kidney had had previous operations on the appendix or gall-bladder.

Although the etiology of nephrolithiasis is obscure, there seems little doubt that infection plays an important rôle. We are reminded by Braasch, however, that even with a large branching stone the urine may contain merely a few microscopic pus-cells or red blood-cells. Even though observers agree that these findings are not diagnostic, nevertheless, according to Braasch and Moore, their presence demands an X-ray investigation of the entire urinary tract. My patient showed much pus in the urine from the left kidney where the stone resided. Therefore, the stone was removed although the renal

function was good. Braasch makes the interesting observation that with single stones the pyonephrosis usually is secondary to the stone formation, but multiple stones are often formed secondarily to the inflammatory process.

It is generally conceded that the continued presence of a stone in the kidney perpetuates the infection and the absence of pus from the urine is a criterion of cure. However, Braasch reports that the urine of 8 of 69 patients found negative on X-ray examination after an interval showed red blood-cells and pus-cells usually scanty. This indicates that a mild degree of infection may persist for a long time after the removal of the stone and that possibly such infection is the original etiologic factor. The 13 cases in which recurrence was proved showed red blood-cells or pus-cells to a variable degree in every instance.

Concerning the surgical treatment of nephrolithiasis pelviolithotomy is the operation of choice by unanimous consent. Barney advocates pyelotomy even though the difficulty of removing stones from the kidney through the pelvis may tax the surgeon's utmost skill and ingenuity. And Eisendrath describes a technic of enlarged pyelotomy for renal calculi which is designed to extend the scope of the usual procedure. Fortunately the applicability of pelviolithotomy is wide since this procedure was employed 206 times in a series of 484 operations for stone reported by Mayo.

Nephrolithotomy is an operation of necessity rather than of choice since damage to the kidney parenchyma and hemorrhage often result. The latter is sometimes severe enough to necessitate nephrectomy. The experimental nephrotomies of Magoun in dogs emphasize the possibility of resultant hemorrhage and infection. Mayo indicates the field for nephrolithotomy in the statement that it was done for example in secondary operations when the kidney was firmly fixed as a result of former operation. Braasch reminds us also that sometimes when the stone is situated in the pelvis or calyces either nephrotomy alone or combined with pelviotomy is preferable to simple pelviotomy if drainage is required for areas of necrosis in the cortex. However the procedure was utilized only forty times in a series of 484 operations for stone. I believe that the frequent necessity for nephrectomy in pyonephrosis and stone (204 nephrectomies in a series of 484 operations reported by Mayo) is due to the insidious onset and progress of these associated conditions rather than to careless observation. Observers agree that the very small symptomless calculi had best be left alone and a policy of watchful waiting adopted. Many of these little stones will pass spontaneously. Braasch also reminds us that some of the patients with bilateral nephrolithiasis are better off without operation because of the absence of subjective symptoms or the large size of the stones. A smaller number was considered inoperable because of the advanced destruction of the kidney or secondary infection. The symptoms apparently were not sufficiently severe to require operation.

The mild attacks of pain which my patient endured for several years finally culminated in an attack which could not be ignored. Even then, however, neither the severity nor the radiation of the pain suggested

renal colic. Apparently, the stone which was anchored in the left kidney remained symptomless.

In view of the right-sided obstruction ureterolithotomy was done as an emergency operation. The effect upon the kidney of ureteral blocking deserves consideration. Barney states that sudden, complete occlusion of one ureter, either experimental or clinical, may produce no symptoms and that uninterrupted recovery will follow in 21 per cent. of the cases. Infection of the kidney due to, or aggravated by occlusion, requires subsequent nephrectomy in 15 per cent. of the cases. One ureter may be completely blocked for ten days without destroying the integrity of the kidney. Of fifteen cases in which the subsequent condition of the kidney was investigated, moderate hydronephrosis was found in 80 per cent.

Caulk and Fischer demonstrated the effect upon the kidney of complete ureteral obstruction by ureteral ligations in dogs. Invariably the kidney soon became hydronephrotic. Caulk and Fischer conclude that if the kidney is to be conserved the obstruction must be relieved within two weeks. Keyes, referring to bilateral calculi, stated that impaction of a stone in the ureter of the sounder kidney may temporarily reduce its function below that of its fellow. Under such conditions it is safer to operate first upon the side with the ureteral stone. Keyes observed, also, that simultaneous bilateral operation may be attempted if the patient's condition is relatively good and the first operation not unduly long.

Since my patient had suffered a complete blocking of his right kidney for an indefinite period, it seemed best to merely relieve the obstruction at the first operation. The function of the right kidney after removal of the ureteral stone was found to be so low that we deemed it advisable to defer operation on the left kidney. We feared that the operative trauma might seriously diminish the function of the overworked left kidney, particularly since the urine from that side contained much pus.

The type of anuria described by Frank which is due to unilateral obstruction by a calculus in the ureter is pertinent to this discussion. Frank believes that anuria may be due to sudden, intense congestion of the unobstructed normal kidney resulting from inability of the efferent vessels to carry off the blood and the consequent stoppage of the urinary excretion.

Frank contends that unilateral calculous anuria is not infrequent as he has seen five cases and has collected 188 reports of the condition from the literature. Although tolerance for anuria of the obstructive type is surprising, Frank nevertheless warns us that relief should be afforded promptly, preferably by pyelotomy on the obstructed side. This procedure results in a resumption of function by both kidneys. The increased liability to cessation of function if the unobstructed kidney harbors one or more calculi is obvious.

The improved function which the right kidney of my patient exhibited three months after the ureterolithotomy justified the delay in operating on the left kidney. The febrile reactions which followed both operations were characterized by high leucocyte counts and the absence of subjective symptoms.

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Lowsley observes that the inevitable urinary leakage following ureterolithotomy invites the laying down of fibrous tissue about the ureter with consequent liability to stricture formation. Therefore, the follow-up examination should include catheterization of the ureter up beyond the point of operation.

Regarding the frequency of recurrence of renal calculi, Braasch concludes that the percentage should be less than ten. Other observers, however, are less optimistic. Cabot, for example, claims that reëxamination of 66 patients previously operated on for renal calculus at the Massachusetts General Hospital showed a recurrence of stone in 49 per cent. Barney states that there is an unfortunate lack of investigation regarding recurrent or overlooked renal calculi. The few available data show that stones are subsequently found in the kidney after operation in a surprising number of instances, but it is impossible to state which of these stones are "recurrences" and which are "left overs." Actual recurrence is unquestionably very frequent. Robins, also, believes that a more careful reëxamination of patients after an interval would reveal frequent recurrences.

Braasch observes, however, that in seventy-five cases the findings on reëxamination were negative, although many of the patients had aches and pains suggestive of recurrence. And in five instances suspicious X-ray shadows appeared which were definitely proved to be extra-renal or extra-ureteral. Also, the urine of several patients found negative on X-ray examination after an interval showed red blood-cells and pus-cells usually scanty at the same time. It is evident that the data suggestive of recurrence must be carefully evaluated.

Regarding the prophylaxis of recurrence, Ochsner strongly advocates the drinking of distilled water. Nevertheless, Lowsley reported the removal of a calculus from the right kidney, later the removal of a calculus from the left kidney and recently the patient has returned with a recurrence in the right kidney in spite of the drinking of distilled water. The statement of Braasch is encouraging, that repeated recurrences in the same kidney requiring a third operation are rare.

*Summary.*—A young man suffered attacks of dull pain in the right side and back during several years. Finally a more severe attack occurred, but the vague subjective and objective symptoms and signs did not suggest calculus. The diagnosis was made by urinalysis, röntgenograms and cystoscopy.

Since nephrectomy is necessary in about half of the cases of nephrolithiasis, either the clinical picture is obscure or else the histories are not well taken. In a series of 484 operations for renal calculi the coexistence of one stone in the kidney and another in the opposite ureter was noted only three times.

A stone which blocks the ureter causes infection and loss of function in the kidney above it. The obstruction must be removed within ten days if the integrity of the kidney is to be preserved. Considering the fact that the function of the obstructed kidney is unknown, it seems wise to defer operation

on the other stone-bearing kidney. The operative trauma under such circumstances might dangerously lower the gross excretion.

Digital exploration of the kidney pelvis and fluoroscopy with the kidney delivered from the incision have minimized the likelihood of overlooking renal calculi. The estimates regarding the frequency of recurrence vary from 10 to 49 per cent. Perhaps the higher estimates are based partly upon overlooked stones. The data suggestive of recurrence are deceptive and must be carefully interpreted.

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## KNEE-JOINT INJURIES AND THEIR MANAGEMENT

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THE injuries of the soft tissues involved in the knee-joint (Fig. 1) may be enumerated as follows:

1. Lacerations of the synovial membrane.
2. Lacerations of the anterior and posterior crucial ligaments.
3. Rupture and traumatism to the fibrous capsule.
4. Tears of the ligamentous structures outside of the knee-joint proper.
5. Injuries to the tendons surrounding the knee-joint.
6. Trauma to the bursæ about the joint.

The injuries to the synovial membrane (Fig. 2) are in themselves not very extensive unless the knee-joint has been punctured by a foreign body or ruptured by a fracture into the joint. In the absence of infection, the membrane heals readily without very much contraction or scar-tissue formation and consequently very little limitation of motion in the joint.

*Hemorrhagic effusions* into the joint are not uncommon from direct trauma. One such case—a young woman who while on the golf course was struck directly upon the patella by a swiftly flying golf ball—was carried from the field and brought directly to the hospital. The joint was already filled with fluid and the aspiration of the joint, which was done immediately to relieve the great distention, showed a large quantity of liquid blood. This aspiration was repeated three times before the hemorrhage ceased. Ice-caps were applied, together with Buck's extension, carrying sufficient weight to separate the articulating surfaces and the patient made a complete recovery. The danger in these cases is obviously the traumatic synovitis and the subsequent adhesions which are so apt to occur.

*The bursæ about the knee-joint* are subject to frequent trauma and infection. Of the twelve which lie about this joint, the three situated in the front are probably most frequently involved. Of these the superficial one or the prepatellar bursa is most often the site of injury. Its involvement is best exemplified in the "housemaid's knee." Because of its location in front of the patella and patellar tendon, it is so easily bruised and punctured and so often becomes infected that it forms a part of the very common minor conditions seen in general practice. Occasionally the bursa about the outer head of the gastrocnemius may become enlarged and require surgical interference. The bursa beneath the tendon of the popliteus lying between the tendon of that muscle and the femoral condyle is almost always an extension from the synovial capsule and frequently swells during an acute synovitis with effusion. This swelling, of course, disappears simultaneously with the decrease of the synovial fluid. The diagnosis lies between swellings and glandular enlarge-

ments in the popliteal space, aneurism of the popliteal vessels and popliteal lipomata, all of which frequently may resemble the enlargement of this bursa.

The pathologic changes which occur depend entirely upon the type, extent and duration of the trauma. A simple direct injury produces serous effusion or hemorrhage and occasionally a rupture of the bursal sac. These simple effusions usually need no other treatment than firm bandaging or counter-

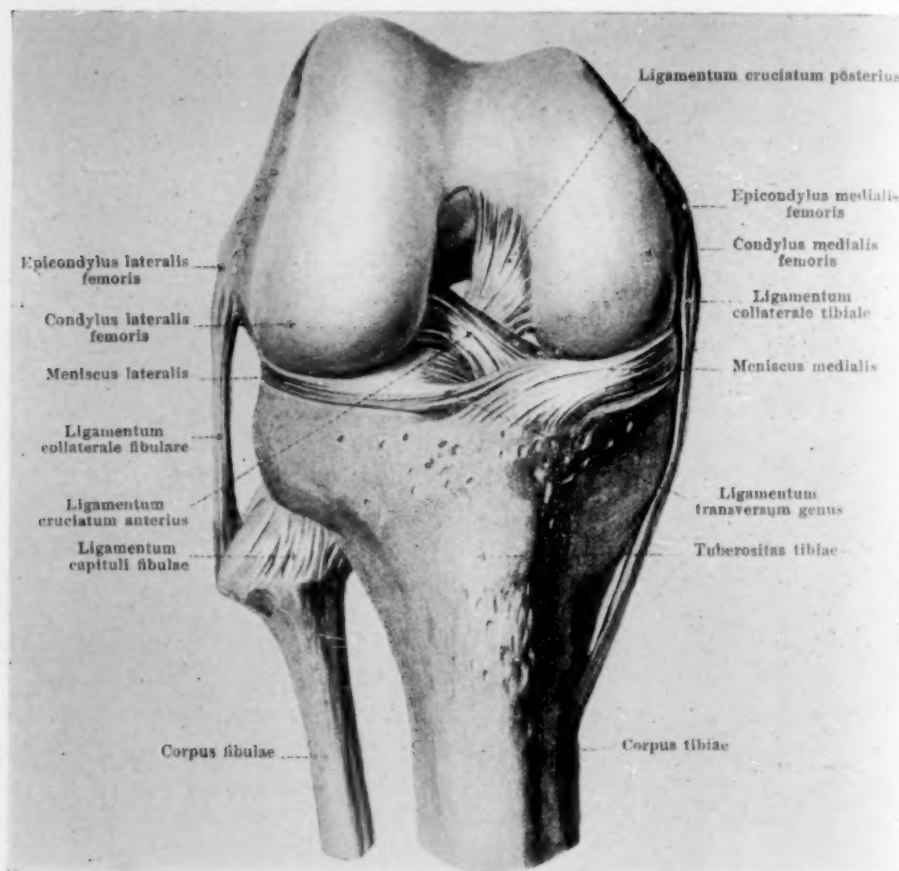


FIG. 1.—Normal knee-joint. (Spalteholz.)

irritation by heat or some other irritant. This, together with immobilization by strapping and rest of the part, is the method used by most surgeons. If this simple procedure does not suffice, aspiration of the sac is undertaken. In the more stubborn cases aspiration of the fluid, followed by the injection of the tincture of iodin, a 20 per cent. carbolic acid solution, phenol camphor or formalin in glycerin may be utilized to a good advantage. In the chronic traumatic involvements, especially those in which suppuration has taken place, there is only one rational procedure, *viz.*: complete excision of the entire bursa. Simple curettement or scarification of the inner lining does not, then, give satisfactory results.

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The *crucial ligaments* are so well protected that they are rarely injured excepting by penetrations through the popliteal space or rupture resulting from dislocation or by fractures into the joint. Occasionally one sees a partial rupture or loosening of one of the crucial attachments in the extreme hyper-

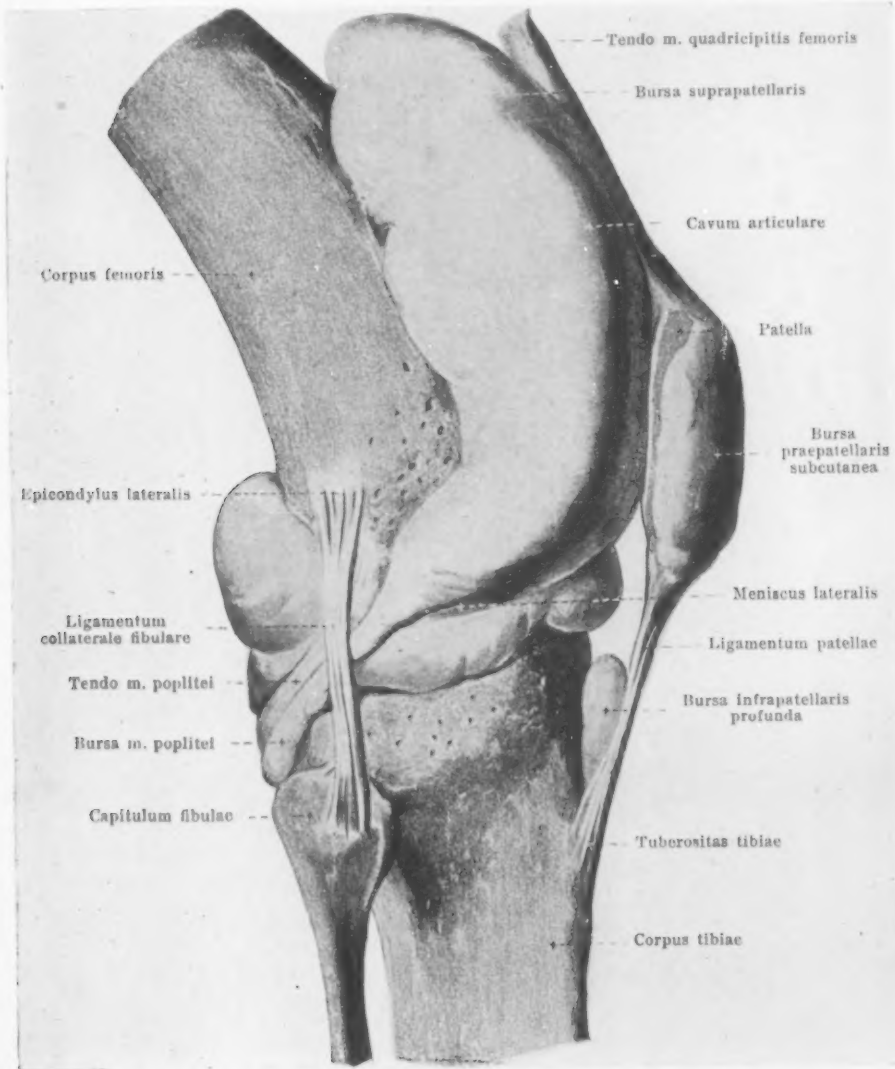


FIG. 2.—The synovial pouch of the knee-joint greatly distended represents the size and general form of the articular cavity when filled with fluid or other material. (Spalteholz.)

extension injuries. There are a number of cases on record in which the spine of the tibia was fractured from the excessive strain on the crucial ligaments. Vulliet<sup>1</sup> reports two cases which were diagnosed by means of the radiograph in which osseous lamellae were torn away, one in the region of the attachment of the posterior crucial ligament and the other in the anterior portion of the

spine of the tibia at the point of insertion of the anterior ligament. In one case which has come under my observation, a portion of the spine was loosened entirely and acted as a foreign body, and when it dropped far back between the condyles of the femur and the tibia it prevented flexion beyond 35 degrees. In the ordinary crucial ligament lacerations, rest and immobilization is all that

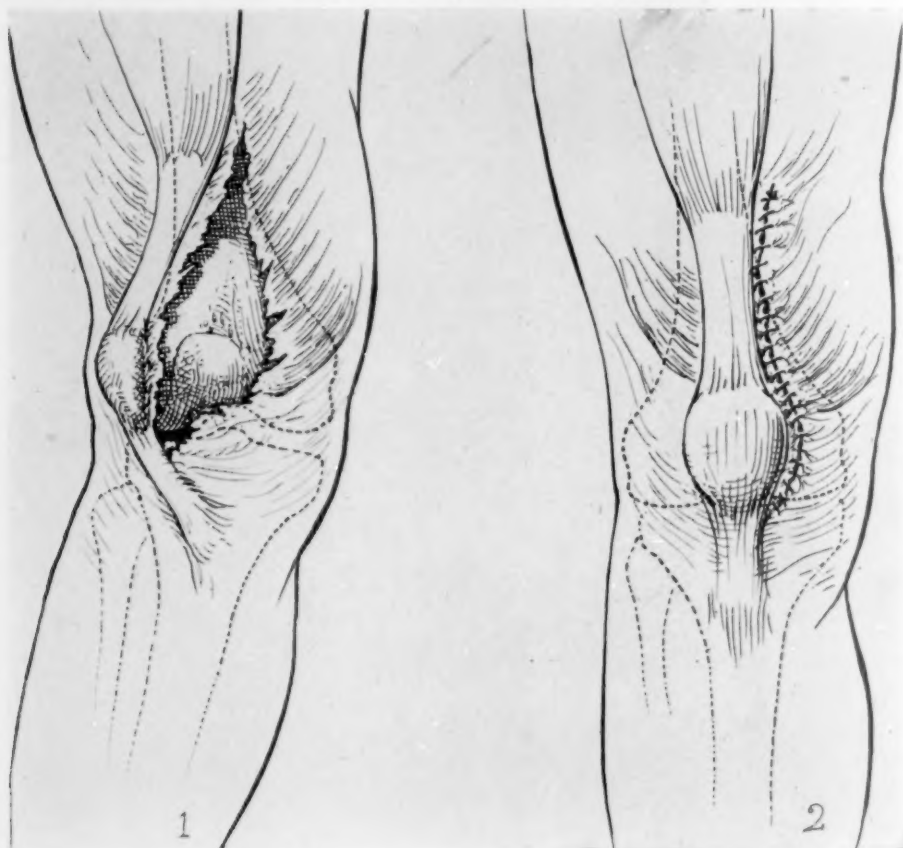


FIG. 3.—1. Dislocated patella and rupture of the fibrous and synovial capsules (antero-posterior view).  
2. Restoration of tissues to their normal anatomic positions.

is necessary. Where there is a fracture of a portion of the bone with misplacement of this fragment, open operation is usually indicated.

*The fibrous capsule* is frequently injured by external violence or penetration and often tears from certain of its attachments, permitting of dislocation of the tibia on the femur or lateral displacements of the patella either external or internal, depending upon which portion of the capsule is torn.

When one considers that the fibrous capsule of the knee-joint in a fresh adult cadaver will stand an internal pressure of about fifty pounds per square inch, one can readily see what great force is necessary to rupture it. The experiments to determine the above fact were made by driving a trocar through the centre of the patella and attaching this trocar to a hydraulic pressure

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pump so graduated that the resistance could be accurately measured. The extent of injury which may occur can best be represented by citing a case which has come into the writer's practice during the past year.

A woman of forty, weighing about 215 pounds, was knocked down by an automobile and struck on the outer side of the right knee-joint. The injury was sustained about a year prior to the time that the patient came for treatment. She walked with the aid of a crutch with the right leg distinctly flexed in a knock-knee position and was unable to extend or further flex the extremity. The patella lay in a fixed position on the outer aspect of the articulation and could not be moved from that position. Careful pre-operative analysis showed that the quadriceps extensor and patellar tendons were not ruptured. There was no dislocation of the femur on the tibia. The fibrous capsule on the inner side of the knee-joint had been ruptured longitudinally to such an extent as to permit of the external displacement of the patella described above. The internal lateral ligaments had been sufficiently torn to permit of the knock-knee deformity (Fig. 3-1).

In the repair of this injury it was necessary to restore these tissues to their normal positions. An extensive exposure of the anterior portion of the knee-joint was accomplished by an incision beginning about four inches above the upper aspect of the patella in the middle of the thigh and extending downward to within one inch of the patella, then curving sharply outward, thus avoiding the patella and following down along the side of it to a point an inch below the patella, then obliquely across the patella tendons ending internal to and slightly below the tubercle of the tibia. This incision penetrated the skin and subcutaneous tissue down to the fascia. The lateral flaps of skin were then dissected from the underlying tissues as far as necessary to expose the structures to be repaired, leaving as much fat as possible attached to the skin. Through such an exposure the patella with its tendons was freed sufficiently from its abnormally fixed position and brought back into its usual place. The rent in the capsule on the inner side was repaired, as shown in Fig. 3-2.

In some cases the injury to the capsule is not sufficiently severe to tear it, but stretches it to such an extent that a recurrent dislocation of the patella takes place either internally or externally as the case may be. The displacement externally is the more common one, as the ridge formed on the interior aspect is much larger than that on the outer. These dislocations recur from time to time when the patient suddenly twists the leg on the thigh with the knee in a partially flexed position.

The repair of this condition calls for an imbrication operation upon the capsule where it has been stretched or loosened, very much as is done in the hernia operation. The mere folding and suturing of the capsule is not sufficient. In another method of operation which has been described in the literature, the tubercle of the tibia with the patellar tendon attached is chiselled away from the tibia and displaced internally or externally as the case may demand. There may be cases in which the use of both operations is indicated. However, it is my belief that the imbrication upon the fibrous capsule is the logical and only necessary procedure in most instances.

Chauvin and Liautard<sup>2</sup> collected 138 cases of recurrent dislocation of the patella in which the majority occurred about the twentieth year and in which 43 per cent. were bilateral. They found the left knee affected more often than the right. Ninety-four per cent. of these cases had dislocations outward.



Meyer<sup>3</sup> utilizes the suture of the long head of the biceps to the patella for internal luxation. For external luxation he recommends Gocht's method of transplanting the semitendinosus muscle to the patella and catching up and suturing the tendinous part of the vastus medialis.

The ruptures of the external ligaments of which there are one internal lateral and two external lateral, may require repair by simple suture in the

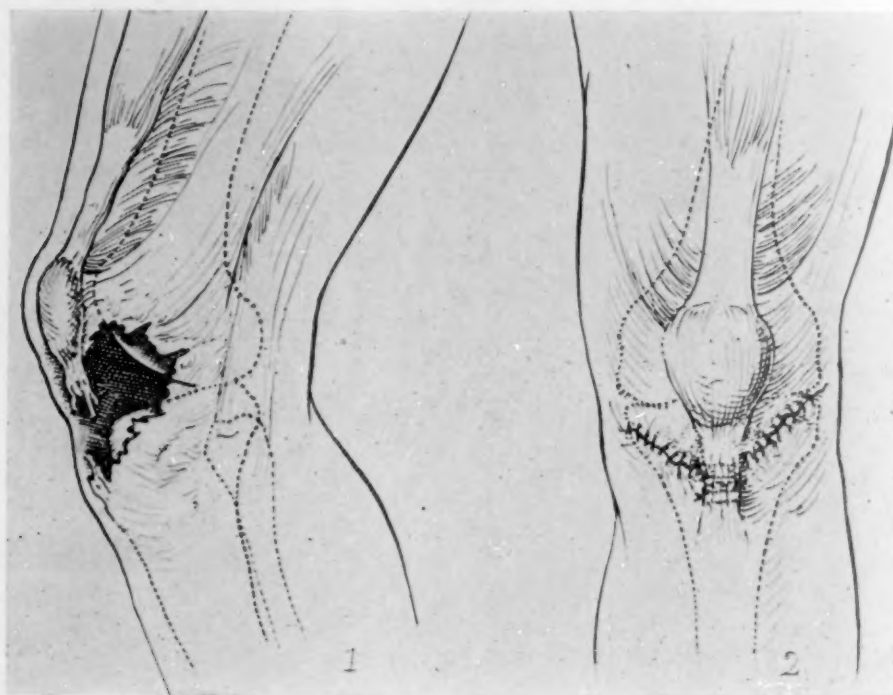


FIG. 4.—1. Extensive laceration of patella tendon and anterior portion of knee capsule. 2. Restoration of lacerated tissues.

early cases or substitution of fibrous tissue from the fascia lata in the old cases.

Of the tendons of the knee-joint, namely, the tendon of the patella and the tendon of the quadriceps extensor muscles, the first named is the one most frequently torn. The two following cases of the patellar tendon and one of the quadriceps tendon, will serve to demonstrate the types of rupture which are apt to occur, their mechanism and repair.

The first case is that of a young man, twenty-eight years of age, who, while exercising in a gymnasium slipped suddenly, throwing the entire weight of the body upon the right knee, which struck upon the sharp ends of a metal bar. The pain thus occasioned was excruciating, the patient fell over, and was carried from the gymnasium floor. The leg was straightened out and very soon the knee-joint began to swell greatly. He was able to flex his leg, but entirely unable to make any effort at extension. He was brought to Mercy Hospital within six hours after the accident, where X-ray examination revealed no injuries of any of the bony parts about the knee. Further physical examination showed that the knee-joint was entirely filled with fluid. The skin was not

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broken. On aspiration this fluid proved to be liquid blood. After this fluid had been withdrawn from the knee-joint the diagnosis could easily be made. With the examining finger upon the skin just below the patella, one could introduce the finger deep into the joint cavity and outline the semilunar cartilages, which fortunately had not been displaced or fractured.

Following the teaching of Murphy that it is unwise and unsafe to perform an open operation upon a joint immediately after accident, I waited for one week until nature had time to throw cofferdaming about the injured parts and until there was no longer any active bleeding into the knee-joint. In this way one can very frequently avoid infections where otherwise a fresh blood-clot and open lacerated tissues would make splendid culture-media. At the end of one week I made a semilunar incision, carrying it an inch lower than the line of rupture in the capsule. Obviously this was done so that our line of suture in the capsule and the skin incision should not lie in the same plane. Upon dissecting the skin back I found on examination nothing intervening between the skin and the joint cavity. After considerable difficulty I found numerous shreds of tissue both long and short, some of them attached to the patella and some just attached to the tubercle of the tibia. This was the remnant of the patella tendon (Fig. 4). The fibrous capsule was torn jaggedly on either side of the patellar tendon, extending inward about two inches and outward one and three-fourths inches. The repair of this proved difficult because I was obliged to gather together the shreds in an effort to make a presentable and sufficiently strong tendon to function in the case of a very large and muscular individual. After the capsule had been repaired and the shreds of tendon brought together, the knee-joint was closed without drainage and placed in a straight two-thirds posterior plaster splint with a Buck's extension of about ten pounds.

The wound healed by primary union, and after six weeks the patient was permitted to make an attempt at flexion. On the last examination, eight months after operation, the patient could fully extend the leg without the slightest difficulty.

A second case is one of a rather similar accident, but with the patella displaced downward instead of upward. A young man of about thirty-two years of age was struck by the bumper of an automobile. The injury was just at the insertion of the quadriceps extensor tendon into the patella. An X-ray showed no bone injury. A splint was applied and the patient permitted to go about for a period of two months. When the splint was removed the patient had no pain and no apparent deformity, but he was entirely unable to extend the leg. Examination at this time revealed, as in the first case, that there seemed nothing to intervene between the skin just above the patella and the femur. Upon closer examination the stump of the quadriceps extensor tendon could be located one and one-third inches above the upper end of the patella (Fig. 5-1).

The incision in this instance was a transverse one, so that we would have plenty of room to make a good repair or, rather to make a re-attachment of the tendon to the patella. After making an incision through the skin we found that we were immediately in the suprapatellar pouch of the knee-joint. The joint contained a very small quantity of a clear fluid and we were most careful not to introduce blood or even sponges into the joint cavity. The stump of the tendon having been exposed in order to bring it down to meet the patella, it was necessary to elongate the tendon at least one and a half inches. To accomplish this elongation two lateral incisions were made parallel and just at the side of the rectus femoris tendon (Fig. 5-2). These incisions extended upward a distance of about two and one-half inches on the inner side and about three inches on the outer side, dividing the attachment of the vastus lateralis and vastus medialis. In this way it was possible to bring the stump of the tendon down to meet the patella. The tendons of the lateral muscles were resutured in their new positions. To make a nice attachment to the patella, the stump was trimmed down so that it could easily be handled with sutures. The patella was then prepared for the attachment by making an incision through the periosteum and deflecting it backward—then three holes were drilled through the patella from before backward and the tendon was sutured to

it with several mattress sutures of kangaroo tendon through the openings thus made (Fig. 5—3). The reflected periosteum was next brought back and united to the tendon.

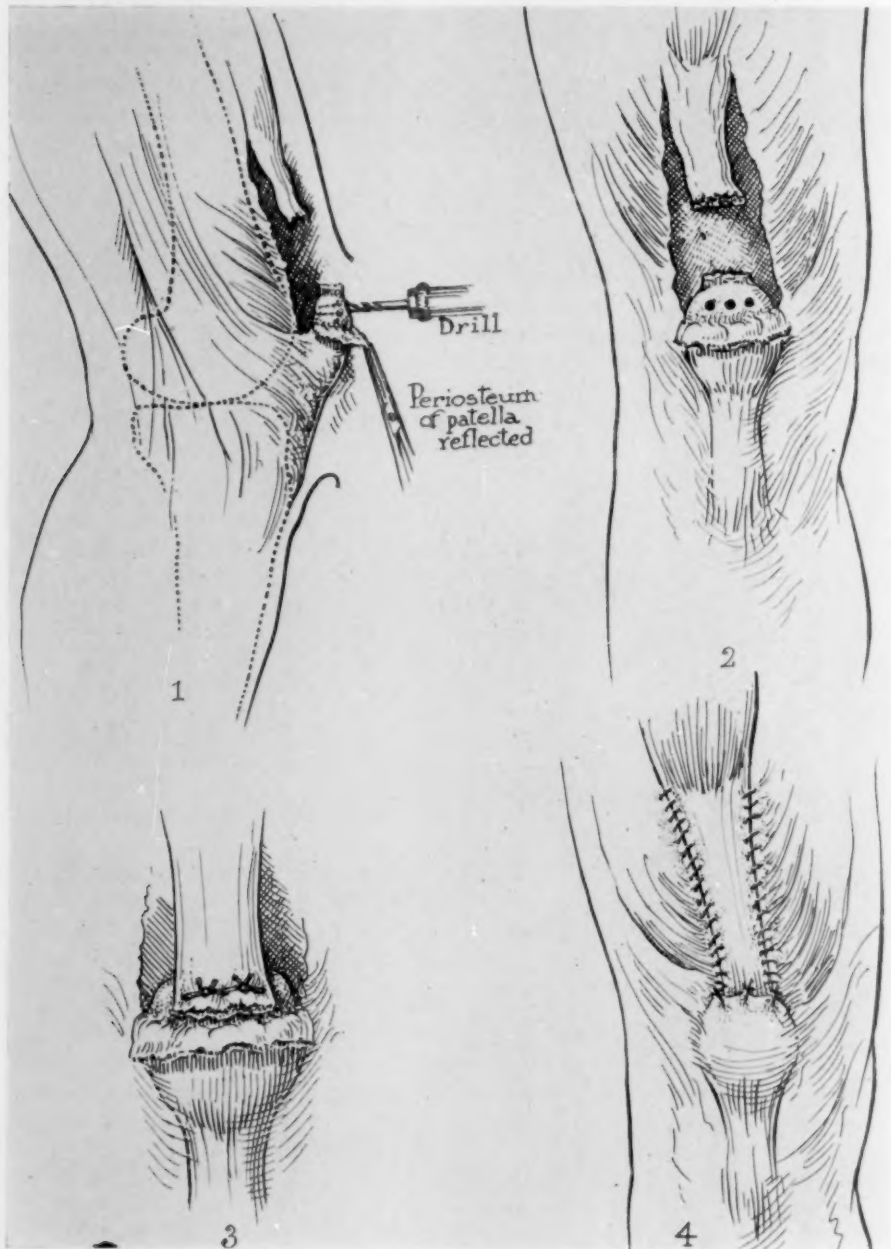


FIG. 5.—1. The stump of the quadriceps tendon has been freed and the patella prepared for the drill. 2. The final preparation for the suture. Note the lateral incisions to permit the quadriceps tendon to be brought down to the patella. 3. Mattress sutures in position, the reflected periosteum to be brought back to cover sutures. 4. Restoration of tissues.

This gave two definite attachments to the patella, one by means of sutures directly to the bone and the other by suturing the periosteum to the quadriceps. By this procedure we

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had no roughened surfaces to which the skin might become adherent and we had not in any way roughened the surfaces on the joint side of the patella (Fig. 5—4). The examination of the case one year after operation showed the knee-joint entirely stable and showed the power of complete extension with considerable strength.

In reviewing the literature on this subject we find very little which gives us an accurate comprehensive description of the processes of repair used by the various operators. There is no one technic which will apply in all cases, one must meet the emergency as it arises. Those tissues which have

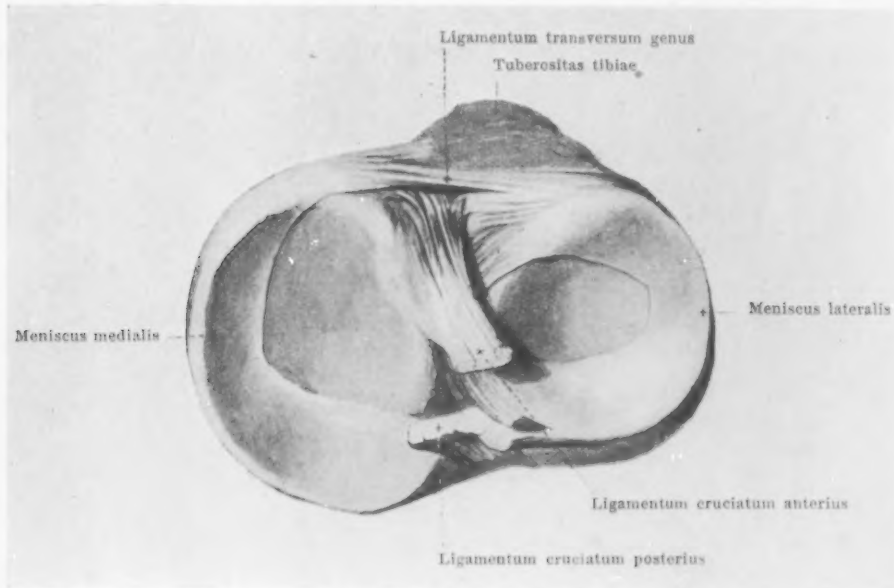


FIG. 6.—The semilunar cartilages and their attachments. (Spalteholz.)

been torn or detached must be reunited. Those tissues which have been so greatly destroyed as not to permit of reunion must be replaced by some similar material from other parts of the body. If there are not sufficient fibres left of the patellar tendon, a portion of the fascia lata may be used as a substitute. If the fibrous capsule is so greatly destroyed that it is impossible of repair, a portion of the same tissue may be transplanted into that part of the knee-joint.

Schwartz<sup>4</sup> reports a case in which the diagnosis of a ruptured patellar tendon was made from the history and from the fact that the patella was abnormally movable. Upon operation it was found that there was only a slight tearing of some of the fibres giving a considerable bloody effusion on both sides of the tendons. The tendon was greatly elongated or stretched by the accident and was shortened by folding the patellar tendon on itself.

*Semilunar cartilage disease*, or internal derangement of the knee-joint, as it is called by the English surgeons, offers one of the greatest fields for surgical interference. These cartilages it will be remembered lie upon the surfaces of the tibial articulating cartilage (Fig. 6) and are in no way attached to it, excepting by the fibrous connective-tissue to the inner side of the knee

capsule along their external circumference. The posterior tip of the cartilage is attached to the posterior crucial ligaments and the anterior tip in the region of the anterior crucials. Lying in this position, thus attached, they are capable of very considerable mobility in various directions but when displaced or torn from these attachments they are subject to certain definite lesions. The mechanisms of these lesions is readily understood when we realize that a large majority of them occur in athletes and among the laboring classes, such as coal minors. Great violence is often brought to bear by the condyle of the femur being shoved upon or against the cartilage. The internal cartilage is naturally the one which is most often injured. The anterior half of this cartilage is much more often the site of injury than the posterior. Various authors give the proportion as 20 internal to 1 external. Rutherford Morrison of Newcastle places the proportion of internal semilunar cartilage injuries as 50 to 1 of the external. Walton in the *British Medical Journal* reports 85 cases, 81 of which were internal. Martin who has treated 449 cases among coal minors found that 92 per cent. were internal. He found that in 95.5 per cent. there were fractures and tears. In my own series the internal cartilage was injured 20 times to 1 external. The lesions may be classified as follows:

1. A simple tearing or detachment of the fibrous tissue holding it in place at its outer circumference, thus permitting it to be drawn into the joint and pinched between the femur and tibia when the knee is extended.
2. A loosening of the anterior tip or one-third of the cartilage which then becomes subject to crushing injuries.
3. Simple fractures of the cartilage in its anterior portion.
4. Multiple transverse or linear fractures.
5. Fraying or nipping of the cartilages with consequent fragmentation. (Fig. 7).

Some of the more unusual accidents are well illustrated in the following cases. In one case the patient sat upon his heel while adjusting an automobile tire and so greatly tore the internal cartilage as to permit it to lie obliquely across the tuberosity of the tibia. Obviously the knee could not be extended, nor could the cartilage be replaced to its normal position by any manipulations, even under anæsthesia.

In another case, that of an athlete, the transverse fracture was so complete that one of the fractured ends extended well into the joint and by repeated extension of his leg over a period of months, caused a deep hole to be gouged into the surface cartilage of the femoral condyle.

In a third case the fragmentation of the loosened cartilage was so complete that approximately fifty small pieces were taken out of the knee-joint at the time of operation.

Another unusual accident is that of a fracture and dislocation of the posterior portion of the internal semilunar cartilage. The patient, a football player, who was avoiding a tackle by a side-step, was struck on front of the knee, causing the leg to be hyperextended with the knee adducted. This mechanism forced the internal condyle of the femur against the posterior portion of the semilunar cartilage and dislocated it, tearing it loose from the circumferential attachment. The pain in this case was internal and posterior instead of anterior as in the more usual cases.



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When once the semilunar cartilage has been fractured or loosened it does not repair nor does it reattach itself, notwithstanding the use of the iodine

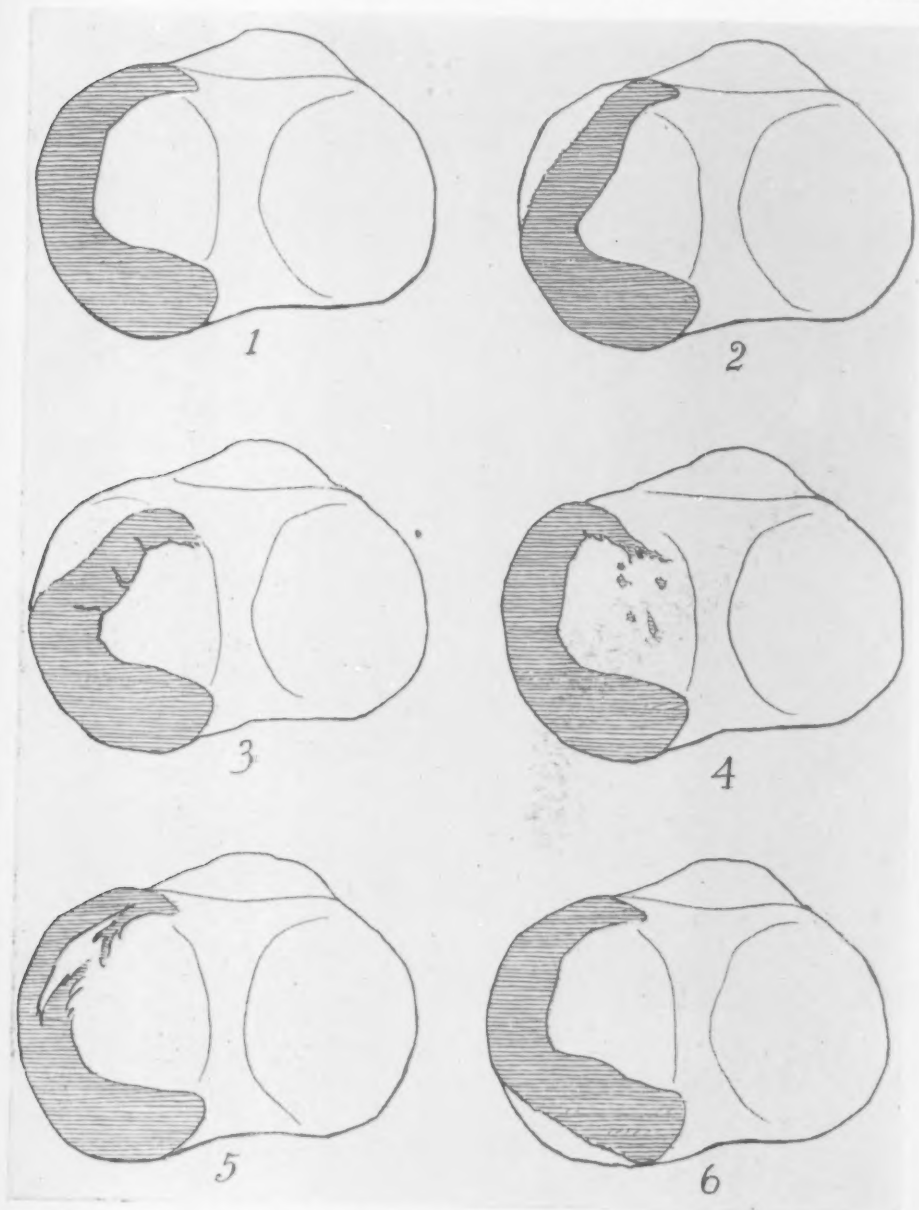


FIG. 7.—1. Normal position of the right internal semilunar cartilage. 2. Rupture of the antero-lateral attachment of cartilage. 3. Detachment of the cartilage along its lateral anterior and internal aspects with multiple fractures and slight fragmentation at the tip. 4. Detachment of the tip with fragmentation. 5. Linear fracture of anterior portion of the cartilage with fragmentation. 6. Partial posterolateral detachment. (Figures 2, 3, 4, 5 and 6 represent five of writers' cases.

injection method of Frauenthal. Complete removal of the entire cartilage in such a condition is the only rational method of treatment.

*Fracture of the Patella* is one of the very disabling injuries about the knee-joint. It may be a simple transverse fracture of the tip of the patella or through the body of the patella. In a number of the cases we have found multiple fractures both transverse and longitudinal. (Fig. 8.) The incomplete fractures which one occasionally sees in the very young need not be mentioned. Golay<sup>5</sup> mentions a verticle fracture of the patella diagnosed by the X-ray in which there were not the ordinary symptoms of fracture of the patella other than sensitiveness over that bone and effusion in the



FIG. 8.—Multiple fracture of the patella.

joint and a slight increase in its transverse diameters. Odermatt<sup>6</sup> explains the great variance in fractures of the patella, by stating that in many cases there is a failure of the several centres of ossification to coalesce and because of this failure in union a fracture takes place more easily than it would in other normal bone.

The patella is a sesamoid bone lying in the tendons of the quadriceps extensor with rather a meager blood supply. A fracture of this bone, therefore, heals slowly and often only by fibrous union. The usual fracture involves the lower one-half of the patella by reason of the nature of the injury. The management of such a fracture is primarily surgical and requires an open operation with accurate approximation and fixation of the fractured portion. The methods of such approximation vary with the experience of the surgeon. A

greatly comminuted or crushed patella may call for complete removal, with a substitution of the extensor tendon or some other similar material. In the ordinary fractures a complete encircling of the patella by wire, kangaroo tendon or chromic catgut is the method of choice. In my operations I hold the fragments in close apposition with a large Lane bone-holding forceps, while the encircling suture is drawn up and tied. In several cases the Lambotte screw was utilized. It is drilled through the lesser fragments into the main portion of the bone, thus holding them firmly in approximation. Willems uses strong horsehair in suturing the fragments to each other. Albee used a transplant of bone from the tibia in some of

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his cases, especially in the late fractures where there has been non-union. Some surgeons favor wiring the patellar fragments through drill holes passing through the various pieces. I believe that this procedure is unnecessary and only tends to weaken the bony structure. Cignozzi<sup>7</sup> advises a gradual bloodless reduction of the fractures by the application of gauze figure-of-eight bandages and adhesive straps. This immobilization he continues for 48 hours, after which time the old bandages are removed and similar tighter ones substituted. Ten such applications are claimed to be sufficient to bring about a complete reduction. This method strikes one as being uncertain and palliative.

An early active and passive motion after wiring of the fracture is indicated to avoid fixations and unnecessary contractures of the tendons and capsule. This, however, must be carried on with great care under the immediate direction of the surgeon himself or a trained assistant. Fredet<sup>8</sup> advises active motion by the patient at the end of several days. The time required to bring about a union of bone depends upon the accuracy of the approximation, the degree of fixation and upon the patient's individual osteogenetic efforts. Some authors have tried to prove that one never gets an osseous union of these fragments. Clinically, however, we are interested only in a patella which is sufficiently strong to perform its function.

*Fractures near or into the knee-joint* offer many difficult problems for the surgeon. No other injury hazards the integrity of the joint more greatly. Therefore these fractures require special attention both from the standpoint of careful approximation and continuous and secure immobilization during the process of healing. In children and adolescents the fractures through the epiphyseal line and the epiphyseal separations are apt to bring about marked deformities which may interfere with the subsequent growth of the

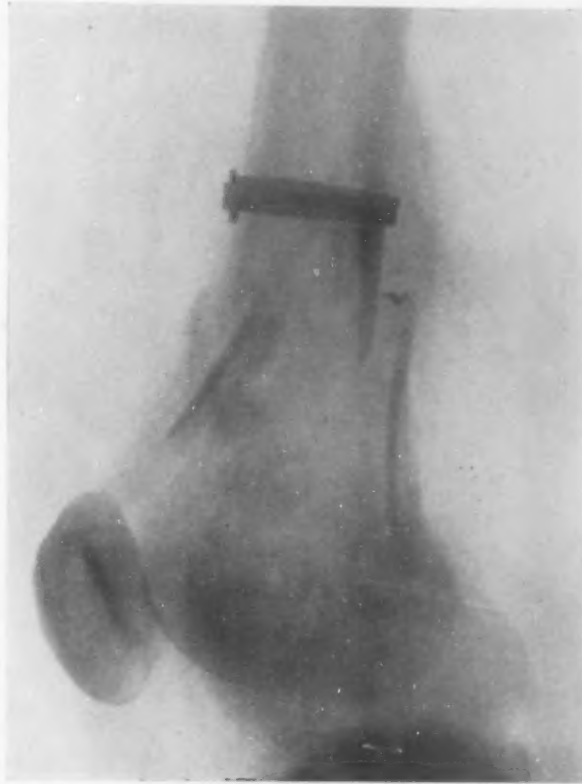


FIG. 9.—Bullet fracture of the femur extending into the knee-joint. Application of the Parham-Martin band.

bone. The lower end of the femur is frequently seen separated from the shaft through the epiphyseal line. In the upper end of the tibia where the fibula acts as a side brace and where the tubercle on its anterior aspect strengthens it still more, the epiphyseal separations are not so common. Barth



FIG. 10.—Scheme showing lines of fracture involving the knee-joint.

assumed that in the region of the epiphyseal bone near the joints, entirely different healing processes obtain than is usual. Bier believes that the synovial membrane penetrates the cleft of the fracture thereby embarrassing the healing.

Axhausen<sup>9</sup> performed animal experiments to disprove these theories. He took out wedge and thin disk-shaped pieces as well as tiny pyramidal-shaped pieces of cartilage from different portions of the articular surface and replaced them loosely. In eight experiments in which deep impression fractures of the joint surfaces were produced, the fragments entered into a firm bony union in every case. The process of healing in the bony portion was exactly the same as the well-known healing process.

The simple fractures of femur in the adults are the transverse fractures above the condyles with Y or T fractures into the joint. The tibia offers fractures through the tuberosities, leaving the central point or intercondylar ridge intact, but frequently with depression of one or the other of the tuberosities with the resultant deformities. In one such case which came

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under my observation a fracture through the external tuberosity permitted that portion of the articulating surface to drop three-eighths of an inch below its normal position. The knock-kneed deformity was obvious and it was necessary to raise the tuberosity to its normal position by open operation. Aside from the disturbance of the joint by uneven articulating surfaces there enters another factor or complication, namely, the hemorrhage into the joint cavity. There is an immediate effusion of blood and serum into the joint and the traumatic exudate about the line of fracture causes the formation of the plastic exudate upon the joint surface and synovial membrane. If the joint is not sufficiently immobilized the formation of exudate continues and hazards subsequent motion. If the joint is kept immobilized too long this plastic material becomes organized and ankylosis results. We must, therefore, re-approximate and immobilize perfectly and begin motion as soon as possible if we wish to avoid inter-articular fixation.

The greatest difficulty is encountered when one attempts to replace the fractured ends which lie within the joint cavity. Traction, counter-traction and manipulation under the fluoroscope yields the best results but even with all of these methods it occasionally becomes necessary to do an open operation for proper reduction. Ligamentous and tendinous attachments to the short fractured ends often bring about distortions of the fragments which require special attention. Placing the limb in such a position as to relax the traction of the tendons is imperative. Various types of screws, staples, nails and wires may be utilized in the proper mobilization of fragments.

In the compound fractures, one has in addition to the usual difficulties the great danger of infection. A suppurative process when once well established in such a joint is not only almost certain to produce an ankylosis but usually demands a removal of the free pieces of bone. Recent experience has taught us that the immediate opening of the joint according to the method of Willems, applying the principles of débridement, gives the very best results. Eising<sup>10</sup> describes this method very clearly by stating that in the treatment of compound fractures into the joint this principle must be applied with primary suture of the joint capsule, and almost immediate post-operative active motion where the fracture does not involve the articulating surfaces. The treatment of such cases by the Carrel-Dakin method is indicated when the infection is superficial and where the hospital facilities are adequate and where nurses and assistants are trained to carry out the daily details as outlined by the originators of this method. It is contra-indicated in the joint or in deep pockets or pouches filled with septic material. It is entirely inadequate in pyocyanous infections and where deep tissues are involved. The same objections obtain for the use of other antiseptic solutions. There is only one treatment for a well-established infection in and about the joint—free and dependent drainage.

The fractures into the joint caused by bullets or other missiles of high velocity are less apt to be infected than the ordinary compounding injuries.



In one such case where the bullet had penetrated through the popliteal space and had partially shattered the lower end of the femur I obtained an excellent result without infection by waiting for ten days until nature had completely walled off the injured area and then through a lateral incision removed the bullet and held the splintered bone together with a Parham-Martin band. (Fig. 9).

In the fractures in and about the joint four fundamental laws must be strictly observed:

1. The peripheral fragment must always be brought in correct apposition with the central fragment.
2. Reduction must be affected by traction, counter-traction, manipulations, and relaxation of the attached tendons or if necessary by open operation.
3. The reduced fragments must be secured in approximation.
4. When infection exists drainage must be dependent and efficient.

*Dislocations.*—Dislocations simple or compound with or without fractures must be managed along the same lines as outlined under fractures. The dislocations must always be reduced under anaesthesia if we wish to avoid extensive traumas to the articulating cartilaginous surfaces. The practice of some writers to permit fractured bones to heal before making the reduction does not commend itself to my judgment.

*Puncture Wounds.*—In the small puncture wounds about the knee-joint the treatment of rest and immobilization frequently suffices to bring about a good result. On the other hand, if the puncture or lacerating wound was of considerable size and has carried with it infectious material there seems to be but one method to adopt, namely that of immediate opening of the knee-joint with thorough cleansing and primary suture. By primary suture I mean a closure of at least the synovial capsule. Drainage is then instituted down to this joint with only partial closure of the fibrous capsule and skin. In this way one often avoids the pocketing and extension of infection which occurs so often in cases completely closed without drainage. Immediate immobilization is the next important step. However, there are those who still believe in the absolute immobilization treatment following laceration of the joint. Before the war, simple drainage with fixation of the joints by splints and casts was the rule. Webb<sup>11</sup> reports a series of 208 cases treated in this manner with 52 deaths, 13 secondary resections and 14 subsequent amputations in addition to numerous cases of ankylosis. In a series of 328 cases treated by mechanical cleansing of the joint followed by primary suture and active mobilization there were 312 recoveries without ankylosis. Those cases which do not come under the care of the surgeon until infection has become well established must, of course, be treated by efficient drainage in the most dependent position and usually with mobilization of the joint. The pus which has burrowed under the muscle and fascia sheaths or has become pocketed in the popliteal space or walled off in other portions of the joint must be opened and completely evacuated. The lacerated wounds of the joint

in civil practice should yield even better results than those obtained during the war. The patient is usually brought into the hospital without delay and comes under the management of the surgeon who follows up the case without interruption. The patient need not be moved from hospital to hospital but is usually kept in the same ward or room under the same supervision. In most instances the infection in cases in civil practice is not so virulent as those obtained in the battlefield and will naturally yield more quickly to the treatment.

When ankylosis occurs with the leg in a fixed or twisted position, motion can be restored by an arthroplastic operation. The mobilization of the knee-joint is such a difficult procedure and involves so many surgical principles that it must be undertaken only by those who have had a large experience in operation upon joints.

*Free joint bodies* or joint mice have their origin (1) from fractures in which small particles of bone have become partially or entirely detached at the time of the accident or were entirely separated from their attachment by the subsequent mobilization efforts of the joint; (2) very frequently portions of the semilunar cartilages detach themselves by comminution of the cartilages or by the nipping action of the femur on the tibia; (3) in cases of extensive hypertrophic villous synovitis a mass of fibrous hypertrophied tissue detaches itself and floats about in the joint often causing symptoms of locking or otherwise interferes with normal flexion and extension; (4) many authors believe joint mice to have their origin only in cases of osteochondritis dissecans, an inflammatory process with varying cartilage and joint surface changes producing loosened portions of cartilage and periosteum. Personally I believe that osteochondritis dissecans as an independent process does not exist, but believe that the histologic pictures are the expression or result of a reaction of the joint tissue to a trauma under certain anatomic and mechanical conditions. Joint mice when sufficiently large as to cause incapacity must be removed by open operation. They are very elusive and because of the frequently associated hydroarthrosis may float into any part of the joint. Those most difficult of removal lie in the posterior pouch of the knee-joint behind the condyles. This recess is divided by a median septum which does not permit of a thorough search excepting through a postero-lateral incision on both sides of the joint. Osgood advises an incision through the popliteal space which is efficient but difficult and rather hazardous in the hands of the general surgeon. Very few of these foreign bodies can be visualized in the X-ray picture and it has been necessary to utilize various methods of fixing them. When once they are localized by the patient or palpated through the skin by the examining surgeon a transfixing needle holds the foreign body in position until it can be removed through an incision. Occasionally it is necessary to do a wide open arthrotomy for the removal of these bodies. I have seen one excellent surgeon resort to the extreme measure of dividing the patella in its long axis, laying

the joint wide open so that he might find a single body which he had not been able to find through a smaller incision.

The subject of traumatic flail joints opens a new field of surgical management. Mühlaus<sup>12</sup> describes a flail joint as a pathologic condition in which there is the ability of abduction and adduction of the lower limb by maximum contraction of the quadriceps muscle. He distinguishes three forms, first the "totter" joint, second the "pendulous" joint, third the "flail" joint. Differentiation of these types depends upon the extent of involvement. They are frequently observed following fractures and shortening of the femur, in which the attachments and insertions of muscles or tendons are brought nearer together.

The management of all knee-joint injuries resolves itself into four distinct equations:

1. A proper diagnosis of the lesion made from the history of the case and physical and X-ray examinations. A study of the mechanism of the accident and a thorough knowledge of the anatomy of the tissues involved are necessary to enable the surgeon to make his decision. The diagnosis by X-ray should be made only from a stereoscopic picture.
2. The surgical procedure involves a careful reapposition of injured tissue whether it be osseous, cartilaginous or tendinous and if this is not feasible, a removal of that portion which cannot be utilized or is foreign to the joint and if necessary a substitution of bone or fibrous tissue from some other part of the body.
3. Operative measures upon a joint must be carried out with the strictest aseptic technic and at such time when nature's walling off or cofferdaming is complete. There is no longer any reasonable excuse for introducing into the joint the operator's finger, any instrument, appliance or sponge which is not absolutely sterile. The joint tissue is as sensitive and as unprotected against infection as the eye and reacts badly to excessive manipulation or trauma.
4. The after-care requires the use of such appliances as are necessary to hold the tissues in position. Active and passive motion must be sufficiently early to avoid excessive adhesions and not so late as to permit peri-articular fixations to form. The application of physiotherapeutic measures, especially diathermy and heliotherapy, must be utilized to the fullest extent.

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(The figures 3, 4 and 5 are from the author's cases reported in The Surgical Clinics of North America and are used here through the courtesy of the W. B. Saunders Company.)

## ARTHROPLASTY OF THE KNEE\*

By WILLIS C. CAMPBELL, M.D.  
OF MEMPHIS, TENN.

MOBILIZATION of an ankylosed knee is generally admitted to be more difficult than parallel conditions in other joints, which is probably due to the fear of instability and that no routine procedure conforms to all cases. Also the chance of success, which has been offered in the past, is so small that few have submitted, in consequence, many surgeons have condemned operative measures from failure in a limited number of cases.

In order that any surgical operation become generally accepted, success must be attained by comparatively simple after-treatment, without incurring



FIG. 1.—Demonstrating apparatus for active and passive motion under control of patient, which was begun on the eighth day after operation.

enormous expense. The consensus of opinion, at present, is that long-continued expert physiotherapy, under the direct surveillance of the surgeon is essential. My opinion, regarding this statement, has been completely reversed within the last few months, and believe that any well-selected case can be offered reasonable chance of success if intelligent coöperation, on the part of the patient, is secured.

In a previous article, *Minnesota Medicine*, September, 1922, I stated that: "In only selected cases should operative procedures for mobilization of ankylosed joints be considered. The following pathological conditions, encountered in such joints, decrease the chance of success or actually contra-indicate surgical measures:

\* Read before the Orthopaedic Section of the New York Academy of Medicine, June 19, 1923.



## ARTHROPLASTY OF THE KNEE

1. Tuberculosis: In no case should a joint be entered for the purpose of mobilization when tuberculosis was the causative agent in the production of ankylosis. Undoubtedly it might be possible to obtain excellent results in some instances, but the probability of "lighting up" a latent tuberculous process is well known and should be sufficient warning.

2. In those in which a destructive osteitis, in early life, has obliterated the epiphyses, a materially shortened extremity is encountered. Mobilization

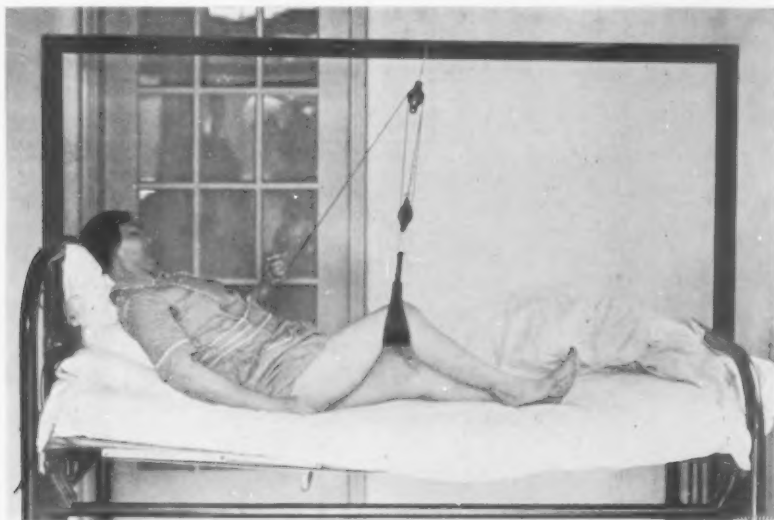


FIG. 2.—Demonstrating apparatus which patient used at home, at the end of six weeks.

of such a joint obviously would not be of sufficient advantage to justify the means.

3. Extensive scar-tissue, binding the skin to the bone, may render the procedure unsuitable, unless preceded by plastic measures.

4. Physiological rearrangement of structure. Extreme muscular atrophy with reorganization of bone structure, as is seen when a bony ankylosis has existed over a long period of time. The medulla may pass through the joint, producing a canalization with rearrangement of the lamellæ. The spongy is transformed into dense bone, making one continuous bone from the ankle to the hip with one canal. In such an instance, sufficient base would not be found to reconstruct a functional joint; besides, the open medullary canal might be a factor to be considered—and, the muscular apparatus being extremely atrophic, the restoration of same would be difficult.

5. Old dense eburnated bone, when found for a considerable distance on both sides of the joint, is not favorable soil for reproduction of a movable joint. Such a condition is usually caused by an extensive virulent osteomyelitis, the result of which is low-grade bone tissue, which bears the same relation to normal bone that scar-tissue does to normal soft tissues. In fact, healthy, spongy bone should compose the articular surfaces of the new joint. Conse-

quently, the chance of success is small, when the structure of the bone has been transformed for one or more inches beneath the joint line.

In ankylosis surgical operations should not be employed for the purpose of mobilization, unless the result of only two causative agents: (1) Traumatism—crushing of the joint surfaces, tearing of the periosteum, or multiple fractures, followed by bony ankylosis; (2) acute infectious arthritis due to staphylococcus, streptococcus, pneumococcus, gonococcus, etc. These organisms erode and disintegrate the cartilages and the superficial bone, unless the infection begins in the shaft, and then we have an extensive osteomyelitis and not a localized arthritis."

The pathology of ankylosis is well known and has been described in previous contributions. The



FIG. 3.—Case XXV. Complete bony ankylosis, previously reported showing extension four and one-half years after operation.

operative methods in fibrous and bony types are indential and require no differentiation. In remodelling the knee-joint no routine technic is applicable to all cases, but must be modified to accommodate the following conditions:

1. Position, extension, flexion, flexion and external rotation and valgus.

2. Distribution of ankylosis. (a) Fusion of patella and femur with tibio-femoral

articulation apparently normal. (b) Tibio-femoral fusion with freely movable patella. (c) Hemi-ankylosis—one condyle and its articulating tuberosity fused with the other half of the joint apparently intact. (d) Pan-ankylosis—complete bony fusion of patella, femur and tibia, by far the most frequent occurrence.

#### OPERATIVE TECHNIC IN EXTENSION

The skin incision is an inverted U, beginning just below the inner tuberosity and passing about one inch above the patella, terminating at the outer tuberosity, a straight incision of four or five inches is made at right angles, about one inch external and parallel with the quadriceps tendon, differing from the Putti approach in that the vertical portion is not directly over the tendon—a distinct advantage. After cutting through fat and fascia, dissection is made over the quadriceps tendon, which structure is lengthened by the common Z-plastic method, leaving the outer half attached to the patella below, which will later be of value in closing. With a large osteotome the union between the patella and femur is severed. The incision is then carried downward to the bones on both sides, as far as the upper extremity

## ARTHROPLASTY OF THE KNEE

of the tibia. The tibio-femoral union is completely severed, no attempt being made to forcibly flex, even in fibrous cases, until this is accomplished, for fractures of the lower extremity of the femur are easily sustained, and may seriously complicate. The knee is then fully flexed, giving free access to the raw bony surfaces of the tibia and femur. In a normal individual, who has no lateral play in the sound knee (previously noted), from one-half to one inch of bone is removed from the femur. The surface is then made convex from before backward and on the same plane from side to side, so that the femur presents one large condyle. The intercondylar notch is obliterated in the process. As small an amount of the upper extremity of the tibia, as possible, is excised in order to reach healthy spongy bone. With a large gouge this surface is made slightly concave from before backward, one large shallow cavity for articulation with the one condyle of the femur, two points of articulation instead of the normal four. No attempt is made to reproduce spine of tibia or intercondylar notch of femur, for there will be no crucial ligaments to prevent lateral displacement, which may easily occur, bringing irregular surfaces together with obvious mechanical damage, when motion is instituted.



FIG. 4.—Case XXV. Showing flexion four and one-half years after operation.

The raw surfaces are next approximated and the alignment of the entire extremity tested. If varus or valgus, more bone is removed from each surface until a perfectly straight hinge is formed. Especial care should be taken not to produce valgus regardless of the position of the normal limb. Future weight-bearing must be direct and in a straight line. The knee is next hyperextended, when there should be at least thirty degrees. If this cannot be attained more bone should be removed except in individuals with very lax joints or atrophic musculature, when ten or fifteen degrees hyperextension is sufficient.

Our attention is next directed to the patella, the posterior surface is removed to a very thin layer, just sufficient to be consistent with tensile strength. The lateral margins are trimmed for one-fourth of an inch so as to allow the periosteal and tendinous fibres to fold backward along the edge of the posterior surface. A large rasp renders all surfaces smooth. All recesses are carefully searched and every particle of loose bone removed. Just below the patella and on the posterior aspect of the patella tendon will be found a mass of fat, and, at times, a layer of synovial membrane, which is severed at the

junction with the tibia and dissected from below upward into a flap with a broad pedicle which is stitched with number one chromic catgut, to the margin of the periosteal and tendinous fibres above described, along the inner and outer edge of the posterior surface. This is an important step, for in those cases in which ankylosis recurs, adhesion begins between patella and femur and is the most difficult problem encountered in restoring mobility.

If the individual is muscular or fat a pedunculated flap may be obtained from the fascia lata external to the quadriceps, the pedicle of which must be broad, and the capsule incised, if necessary, to permit easy passage without constriction. With the deep surface turned out this is carried across the outer femoral condyle and attached to the inner condyle and posterior capsule. Recently we have transplanted the free fascia lata from the outer aspect of



FIG. 5.—Case I. Patello-femoral fusion with loss of quadriceps tendon. Routine arthroplasty with plastic restoration of quadriceps from vasti.

the opposite thigh, taking a very large sheet, four or five inches in width by eight or ten inches in length, turning the deep surface out, as one of the functions of this membrane is the free easy play of the muscles beneath. This sheet of fascia is placed over four or five inches of the anterior aspect of the femur and attached muscles, being anchored above to the deep fibres of the muscles, it then passes over the condyle of the femur and is stitched to the

posterior capsule, as high as possible, after which it drops downward along the posterior capsule and finally forward to the anterior surface of the tibia, all free edges are stitched with continuous chromic catgut well over the margins of the joint. The joint remains flexed sixty degrees for closure, as the capsule may be contracted, and if closed in extension free flexion would not be permitted, thus defeating the purpose of the operation. The inner portion can always be united as the vastus internus extends lower and there is more resiliency in the soft parts on the inner side. For this reason the quadriceps tendon is severed above, through the outer half, and below, through the inner half, so that the outer half is attached to the patella. If the edges of the capsule cannot be brought together in flexion, a flap of fascia or muscle may bridge the defect, as it is absolutely essential to restore a closed intact mechanical joint. The quadriceps tendon, fascia and skin are sutured in routine manner, using chromic gut for deep structures and dermal suture for skin.

## ARTHROPLASTY OF THE KNEE

### TECHNIC IN COMPLETE ANKYLOSIS IN FLEXION

When ankylosis occurs in flexion the anterior structures are redundant after removal of sufficient amount of bone, however, severance of the posterior capsule may be necessary, though stripping of the periosteum above and below, for one or two inches, has been found sufficient. The quadriceps tendon can be retracted to the inner side without dividing, which is an obvious asset. The greater the degree of flexion, the larger the amount of bone excised.

### TECHNIC IN FUSION OF PATELLA AND FEMUR

In fusion between patella and femur, with an apparently normal tibio-femoral articulation, the position is always extension or possibly very slight flexion. The patella is treated as above described, with a broad sheet of fascia lata, from the outer aspect, folded beneath the patella and quadriceps tendon, being retained *in situ* by stitching to the vastus internus, the deep surface of the fold facing the patella and quadriceps. This is not a pedunculated strip, but a living viable fold. When scar-tissue invades, a free fascial transplant is taken from the opposite thigh. If the capsule space is not of sufficient size to allow flexion, plastic adjustment is required as above described.



FIG. 6.—Case I. Showing degree of flexion two years after operation.

### TECHNIC IN TIBIO-FEMORAL FUSION WITH FREELY MOVABLE PATELLA

When tibio-femoral fusion occurs, with a freely movable patella, the incision should be U-shaped across the patella tendon. The patella tendon is lengthened by Z-plastic method, after which the new joint is remodeled as above described. This condition is not a sequela of acute infectious arthritis, but, usually, the result of a virulent infectious osteomyelitis, with direct bone infection across the joint space, the anterior portion of the joint being protected and walled off by inflammatory exudate, a counterpart of which is so frequently seen in the abdominal cavity.

### TECHNIC OF HEMI-ARTHROPLASTY

Occasionally a considerable portion of the joint surface is intact and may be conserved. This may frequently be accomplished in the elbow and shoulder, as described in *ANNALS OF SURGERY*, November, 1922, vol. lxxvi,



No. 5, as hemi-arthroplasty. After remodelling the affected portion a pedicle flap is usually quite sufficient.

There are several points to be elucidated and emphasized. 1. The amount of bone to be removed depends on the position of the limb, the contracture of the soft parts and the musculature of the individual. Roughly speaking, from one to one and one-half inches, though possibly as much as two inches has been removed. A satisfactory degree of hyperextension must be secured.

2. *Inequality*.—Shortening has never been of practical disadvantage nor a question of consequence, if a movable joint is attained. If over two inches a stiff joint, in an improved position, would be more satisfactory.

3. *Instability*.—An unwarranted fear if one remains within the bounds of reason and does not remove too much bone from the pedestal—the tibia.



FIG. 7.—Case II. Complete ankylosis. Extension after third arthroplasty.

4. *Material Interposed*.—When no substance is interposed ankylosis usually recurs regardless of the efficiency of the after-treatment. A tissue of some type should be inserted between the denuded surfaces, for it is an undisputed fact that fascia, muscle and periosteum, between fragments of fractured bones, are a possible cause of pseudo-arthrosis. Animal

membranes have been employed but possess the disadvantage of foreign-body irritation, invite infection and may be extruded. Either the pedunculated fascia lata or the free fascial transplant should be selected as indications demand, being careful to place the deep layer on the surface of the joint as described. The fascia lata is not only desirable, from its strong fibrous composition, but the deep surface is smooth and glistening and its function is the easy play of the strong muscles of the thigh. A histological examination of this membrane was made by Prof. O. W. Hyman, of the University of Tennessee, which showed that the deep fibres were parallel, having the same structure as tendon tissue, being connected with the muscles by loose areolar tissue.

There have been no serious complications. Infection will occur in a high per cent. on account of extensive raw bony areas being so near the surface with the incident copious drainage. Even a severe infection with thorough Dakinization does not necessarily prevent an excellent result. Ankylosis may recur in spite of most careful after-treatment.

There has been much speculation as to the physiology and histology of such a joint. We have operated four times for recurrent ankylosis, after

## ARTHROPLASTY OF THE KNEE

arthroplasty, once in two cases, and twice in one, about six months elapsing between each operation. In three of these cases there was about ten degrees voluntary motion. In these we found the patella adherent through scar-tissue. There were fibrous bands connecting the tibia and femur, alternating with areas of cartilage and heavy fibrous tissue on the articular surface. The superficial spongy bone was dense and hard. No evidence of bursa, hygroma or synovial membrane could be macroscopically or microscopically demonstrated. We have had no occasion to incise a knee-joint in a successful case, but in all probability the articular surfaces, after an elapse of one or more years, are encrusted with an atypical fibro-cartilage, supported by a dense layer of bone, the fibrous cells, in time, being flattened under pressure and may assume, by functional adaption, an endothelial type secreting sufficient fluid for lubrication. In fact, it is hardly conceivable that any other process, consistent with joint function, could occur.

### THE AFTER-TREATMENT

As soon as the operation is completed the limb is placed in a Thomas splint, with a joint at the knee, and a hoop of steel connected just above and anterior to the knee-joint. A rope is attached to the centre of the hoop and overhead to a simple wooden frame. A second rope is attached to the lower extremity of the Thomas brace, which passes directly upward to the wooden frame, through a series of pulleys, to the head of the bed, where it is attached. By adjusting these two, any desirable angle may be maintained and by gravity of the leg, under direct control of the patient, passive and active motion instituted (Fig. 1). The limb is first placed in the extended position with moderate traction, except in patello-femoral fusion, when flexion is desirable. No motion is instituted until local reaction has subsided, which requires about eight or ten days. Active motion is encouraged with special attention to the development of function in the quadriceps. Passive motion is carried out by the patient, who is given the end of the rope, which is detached from the head of the bed, and by gravity of the leg flexion is made. The subject soon finds that considerable motion is possible without pain. The splint is removed in about six weeks, depending on the stability of the joint, and a simple overhead sling, with block and tackle, substituted (Fig. 2), when walking on crutches is permitted. Weight-bearing is gradually increased with care to avoid reaction. In resistant cases brisement forcé is of value, if



FIG. 8.—Case II. Showing degree of flexion.

cautiously employed, under nitrous monoxid, with full extension and only ten degrees increase in flexion on each occasion. The value of physiotherapy should not be underestimated, though, by no means essential to success, if the measures above described are closely followed by the patient. Total disability is expected from two to three months, partial disability for six months depending upon the occupation of the individual.

Complete extension is essential, sixty to ninety degrees flexion gives the best functional results and a member which can be used for all practical purposes.

In an article in *Jour. Ortho. Surg.*, September, 1921, vol. iii, No. 9, twenty-four cases were reported, of these only thirteen were suitable for final analysis, nine of which obtained voluntary motion, but only five of sufficient degree to be classed as satisfactory or excellent. Since



FIG. 9.—Case III. Complete bony ankylosis showing degree of extension three months after arthroplasty.

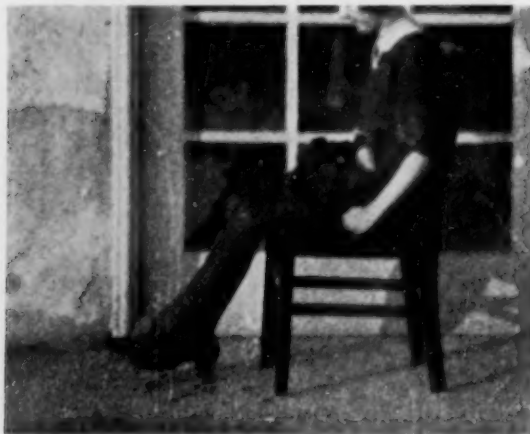


FIG. 10.—Case III. Showing degree of flexion.

this time we have encountered a larger number in a shorter space of time, which has offered an opportunity to make a more careful analysis of the condition, and to formulate procedures and routine after-treatment with a substantial increase in the percentage of satisfactory results.

Since the previous reports, above mentioned, we have operated sixteen knees for the purpose of restoring motion, making a total of forty arthroplasties. Twelve of the sixteen had a solid bony ankylosis of patella, femur and tibia, two fusion of patella and femur, two fibrous ankylosis. Eight were in malposition of flexion with or without external rotation; eight were in extension. The ages ranged from thirteen to thirty-six. In two the etiological factor was compound fractures with infection, the remainder, sequelæ of acute purulent infectious arthritis. Radiographs in all showed normal spongy bone, a short distance beneath the joint line. In three no tissue was inter-

## ARTHROPLASTY OF THE KNEE

posed between the articular surfaces. In two of these ankylosis recurred though very careful after-treatment was rigidly carried out. One obtained a very successful result, 90 degrees free motion. Of the sixteen, ten were successful, the degree of voluntary motion secured was 60, 80, 80, 90, 60, 80, 50, 40, 40, and 30. Pedunculated fascial flap was interposed in four, free fascial transplant in five and no tissue in one. Two, in which no material was interposed, were failures. In four it is too early to reach conclusions. There were ten successful and two failures,  $83\frac{1}{3}$  per cent. In two, with ankylosis of seven and eight years' duration, a slight laxity prevails, but should improve with muscle training. Sufficient time has not elapsed to determine the permanency and durability, consequently, this report cannot be received as conclusive, but encouraging, however, from past experience we would conclude that the range of motion and function will be materially increased in all successful cases. Two cases have been under observation for four or five years, respectively, each of which has practically a normal knee—one is on constant duty as a nurse (Figs. 3 and 4).

Of the sixteen, infection occurred in four, three of these required Dakinization, counter-drainage, etc., but obtained a successful termination with free voluntary motion, which proves that even infection may not inhibit the result.

One of the successful cases was in a boy thirteen years old, but care was taken not to disturb the epiphyses. Such procedures in children require constant supervision of an indefinite period.

My first report was by no means encouraging but from results obtained, especially during the last year, arthroplasty of the knee is justifiable in well-selected cases, with an excellent chance of attaining satisfactory motion.

All cases were white adults with one exception, a white boy of thirteen. Only the essential facts are related in the following:



FIG. 11.—Skin incision, arthroplasty of the knee.

### CASE REPORTS

CASE I.—Mr. B. W., age twenty-one, cause, compound fracture of the femur with complete loss of quadriceps tendon, duration two years, bony ankylosis patella and femur, tibio-femoral articulation apparently normal, excessive scar-tissue in thigh from prolonged infection, position extension. Operation, April 8, 1921. Routine procedure except that prepatella bursa was dissected out and placed over denuded surface of patella. Quadriceps tendon reconstructed from a strip of muscle tissue about one inch in diameter, from each vastus muscle. A severe infection ensued requiring Dakinization for three weeks, when routine after-treatment, above described, cautiously instituted solely by the patient himself. Drainage persisted for six months. Result full extension 60 degrees flexion. (Figs. 5 and 6).

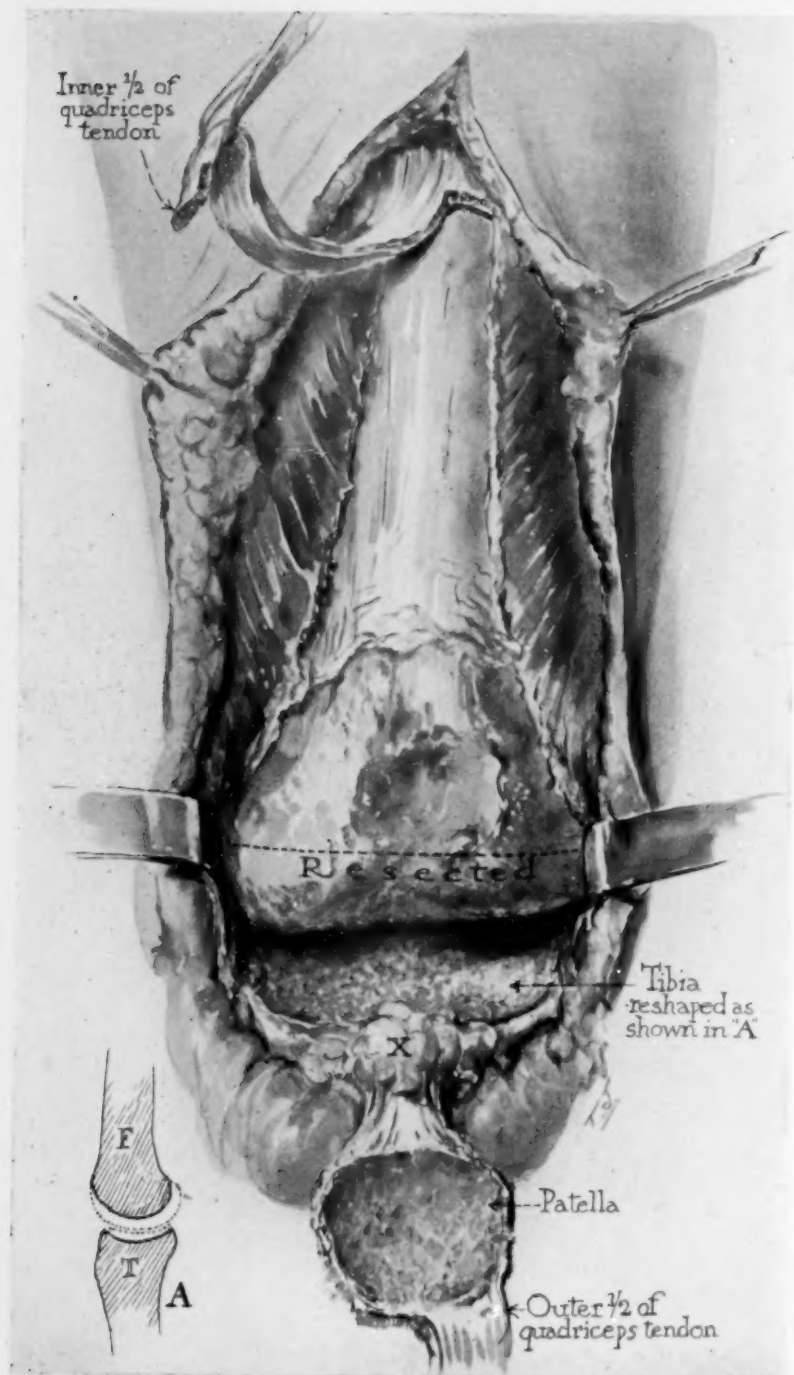


FIG. 12.—The making of one large condyle of the lower extremity of femur and one shallow cavity of the upper extremity of the tibia. As much of patella removed as possible.



## ARTHROPLASTY OF THE KNEE

CASE II.—Mrs. M. H., age twenty-three, cause, acute infectious arthritis. Two previous arthroplasties with failure, duration two years, complete bony ankylosis. Third arthroplasty May 26, 1921, free fascia lata transplanted. On the third day aborted, on the sixth day walked about room on Thomas splint which was followed by infection. Routine after-treatment by patient as soon as acute symptoms subsided, one gentle brisement forcé at the end of three months. Result—complete extension 80 degrees flexion, no instability after three arthroplasties. (Figs. 7 and 8.)

CASE III.—Mrs. R. C., age twenty, acute infectious arthritis, complete bony ankylosis, duration one year, position extension. Routine procedure June 14, 1922. Pedunculated fascial flap interposed, physiotherapy two weeks, otherwise after treatment solely by patient. Result, slight hyperextension, 50 degrees flexion. (Figs. 9 and 10.)

CASE IV.—Mr. M. C. B., age twenty-two, acute infectious arthritis, complete bony ankylosis, duration seven years, position 90 degrees flexion. Routine procedure, August 10, 1922, free fascial transplant, after treatment routine by patient, no physiotherapy. Result complete extension 70 degrees flexion, slight instability necessitating a brace which should be discarded in a few months.

CASE V.—Miss M. L., age thirty-six, very fat, acute infectious arthritis, complete bony ankylosis, duration two years. Position 30 degrees flexion with external rotation. Routine procedure April 12, 1922, no material or tissue interposed, physiotherapy four months. Result complete extension 80 degrees flexion.

CASE VI.—M. C., age twenty-nine, thin, frail, acute infectious arthritis, complete bony ankylosis, position extension, duration eight years. Routine procedure but only ten degrees hyperextension on account of weak musculature, free fascia lata transplanted, physiotherapy six weeks when discontinued on account of physical condition. One gentle brisement forcé. Result full extension 90 degrees flexion, slight instability which is rapidly improving with increased muscle function.

CASE VII.—Mrs. M. C., age thirty, acute infectious arthritis, pan-articular fibrous ankylosis, 20 degrees free motion. November 1, 1921, modified procedure with conservation of joint surface, leaving areas of cartilage intact. Pedunculated fascial flap interposed, severe infection, 50 degrees free motion with full extension, routine after-treatment by patient.

CASE VIII.—I. W., boy, age thirteen, acute infectious arthritis, complete bony ankylosis, duration two years, position 75 degrees flexion. March 2, 1922, routine procedure with care not to invade epiphyses. Pedunculated fascial flap interposed, marked tendency to recurrence, gentle brisement forcé otherwise routine after-treatment by patient. Result 40 degrees free motion with mild genu valgum.

CASE IX.—Mrs. G. W. S., age twenty-five, acute infectious arthritis, duration one year, position 60 degrees flexion, April 10, 1922, routine procedure with no tissue interposed, physiotherapy two weeks when recurrence was inevitable and patient dismissed with correction of deformity.

CASE X.—Mrs. N. K., age twenty-two, acute infectious arthritis, bony ankylosis between patella and femur. Fibrous between external condyle of femur and external tuberosity of tibia, inner half of joint a few adhesions, cartilages intact, about ten degrees painful motion. Duration nineteen years, position 20 degrees flexion. November 18, 1921, hemi-arthroplasty with pedunculated fascial flap in external half of joint and between patella and femur. Routine after-treatment with physiotherapy, result complete extension 50 degrees flexion.

CASE XI.—Miss R. J., age nineteen, acute infectious arthritis, complete bony ankylosis, duration eleven years, position 70 degrees flexion. April 14, 1922, routine procedure without interposition of material between joint surfaces, expert

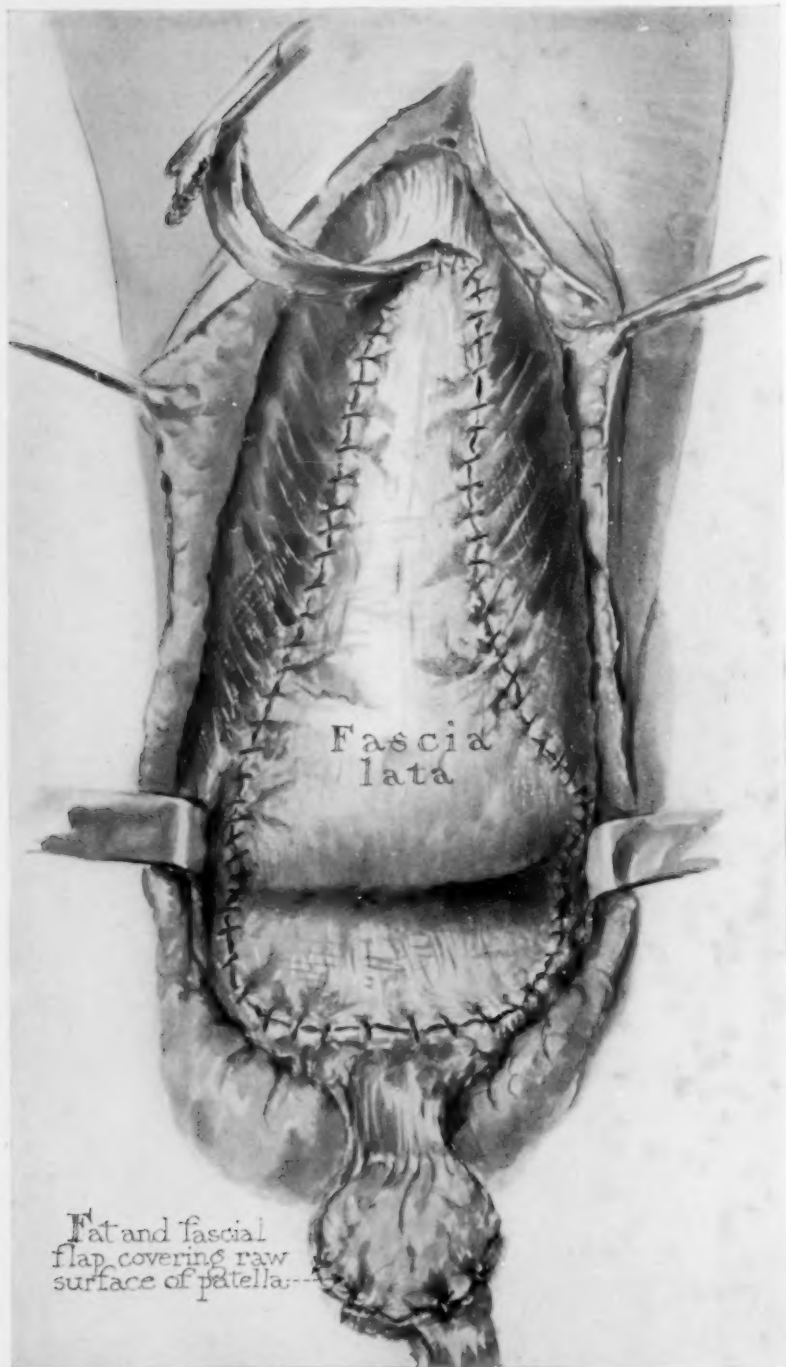


FIG. 13.—Anterior view after interposition of fascia lata from opposite limb.

ARTHROPLASTY OF THE KNEE

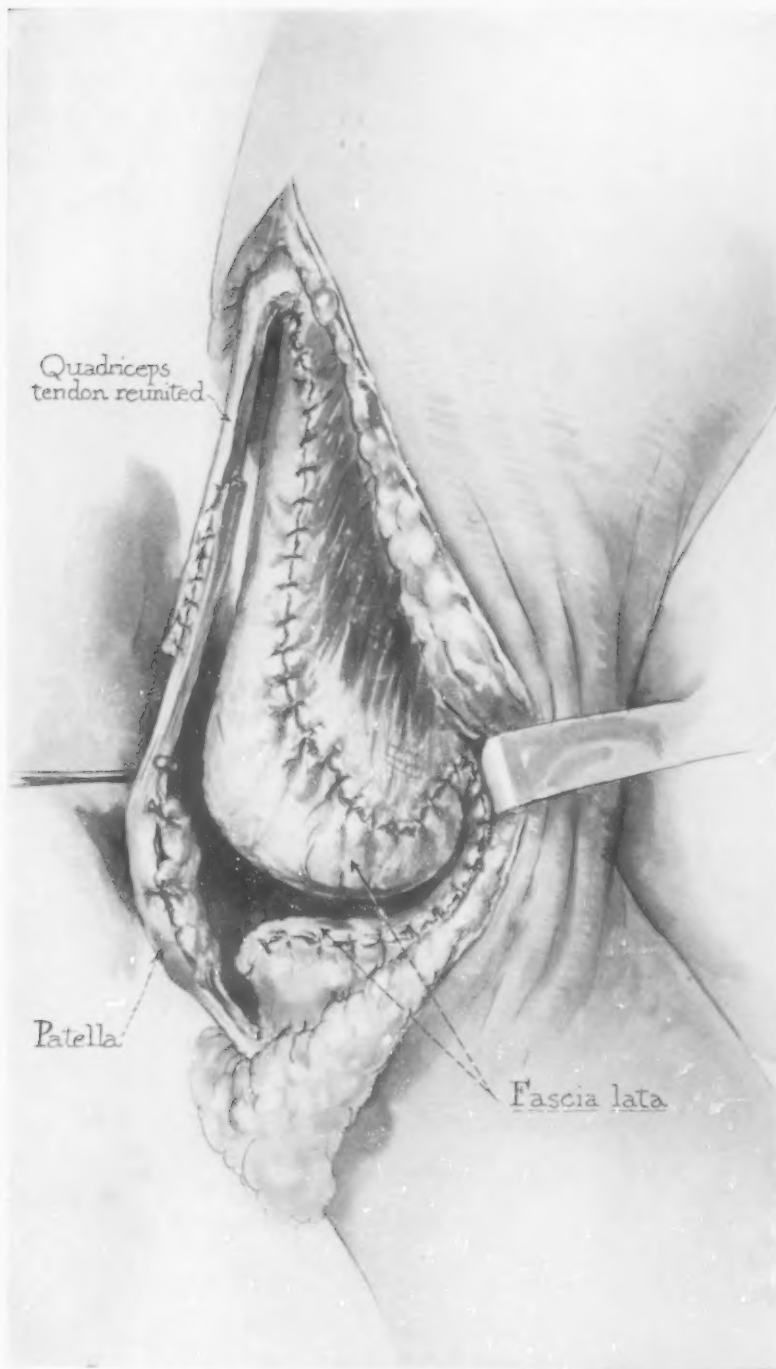


FIG. 14.—Side view showing area of attachment of fascia lata, and pedunculated flap covering patella.

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physiotherapy long-continued. Gentle brisement forcé three times. Ankylosis recurred in position of complete extension.

CASE XII.—Miss O. E., age sixteen, acute infectious arthritis, complete bony ankylosis, duration one year, position extension, routine procedure August 2, 1922. Free fascial transplant from opposite knee, result 40 degrees flexion, full extension, range of motion increasing.

As results cannot be stated in Cases XIII, XIV, XV and XVI, no history is given at this time.

## FRACTURES ABOUT THE UPPER END OF THE HUMERUS

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THIS paper analyzes seventy-five fractures of the upper end of the humerus admitted to the Second Surgical Division at Bellevue Hospital, since 1916, or observed and treated by the writer outside of the hospital. They are consecutive cases and most of them have been observed for a sufficient length of time, so that it seems fair to make deductions as to the efficiency of the treatment adopted and as to the disability resulting from fractures in this location. This study has been limited to fractures of head, neck and adjacent portion of shaft (one and one-half inches below the lesser tuberosity), because the disabilities in abduction and rotation resulting from fractures in this region seem to be due to certain pathological factors which may bear emphasis and which differ from the factors concerned in fractures lower in the shaft.

The individuals in this series show an average age of 50.4 years. Eighteen were over sixty years of age, seven over seventy, one was over eighty. Thirty of the patients were women. On careful analysis of the histories, all these fractures were caused by direct violence with the possible exception of three cases—one a long comminuted fracture obliquely downward from the surgical neck, from a fall on the palm of the hand; one a spiral fracture from surgical neck through upper third of the humerus, from a fall on the elbow; one a fracture of the anatomical neck with dislocation of the head out through the capsule, from a fall on the extended arm. All these exceptions are, I think, susceptible to question as to the indirectness of the causative violence.

Twenty-one of these cases were admitted to the hospital two days or more after injury; sixteen were seen three days or more after injury. Eight, nine, eleven and forty-two days represent the limits in time before positive diagnosis was made. In fairness and honor to the profession, however, it should be stated that practically all of these cases had received medical advice which recognized the serious nature of the injury but due to exigencies of family life or natural procrastination, they had failed to report earlier for treatment.

Thirteen of these cases have had associated injuries at the time of admission, in some this associated injury representing the major surgical condition. These injuries were fractures of femur, four; fracture of adjacent clavicle, two; acromioclavicular dislocation, one; fracture of olecranon on same side, two—one with no separation, one with well-marked separation; Colles' frac-



ture same side, one; fractured ribs same side, two; dislocated meniscus, one. General contusions and abrasions have naturally been frequent and considering the average age of these patients not without significance.

In analysis these fractures have been grouped not only on anatomical lines, but also on the basis of pathological displacement which, according to its degree, renders easy or difficult the subsequent treatment. Grouping on purely anatomical lines is, I find, more difficult than it first appears for many of these shoulder injuries when first rayed on a flat plate in two planes will



FIG. 1a.—Dislocation of the head of the humerus, with fracture of the greater tuberosity. Condition on admission, July 3, 1923.

appear to fall into one group, whereas later check up with muscles relaxed and the patient in comfort will bring out lines of fracture which make them fall definitely into a different group. On such a basis, subject as it is to elements of error, these fractures for purposes of discussion are grouped as follows:

1. Anatomical neck, 4; (a) simple, 3; (b) with dislocation, 1.

2. Greater tuberosity, 5; (a) simple, 4; (b) with dislocation, 1.

3. Lesser tuberosity, 2; (a) simple, 0; (b) with dislocation (posterior), 2.

4. Surgical neck, 64; (a) simple with slight or

no displacement, 13; (b) simple with gross displacement, 31; (c) complicated-combining gross displacement of neck with greater tuberosity displacement, 17; (d) with dislocation, 3.

In the above groups, fractures of the anatomical neck have been rare. The patients in whom it was diagnosed were aged fifty-three, seventeen, seventy and fifty. The first case presented a picture of comminution of the head and this was excised through the surgical neck. The last case showed the head dislocated anteriorly through the capsule and this was excised along with the upper end of the shaft. The operative indications appeared clear,

## FRACTURES UPPER END OF HUMERUS

the results, however, were poor. Cases II and III were treated by suspension, abduction and rotation. The results were ultimately good.

Isolated fracture of the greater tuberosity occurred five times. In no case was indirect violence given as a cause. In one case (Fig. 1a and b) an accompanying anterior dislocation was present. In two other cases a history of reduction of a dislocation previous to admission was given. That this is open to question is obvious, although it is interesting to note in view of the statement in practically all text-books on fractures that such a fracture may accompany anterior dislocations. The displacement in the five cases noted was not marked, and in no case was it comparable to the displacement of this fragment when accompanied by fracture through the neck. The disability in these cases, however, was very marked, and seems to place this fracture in a class with fractures of the scaphoid in the great disproportion between the size of the fracture and the amount of disability. This disability was present whether the fragment was large or small, and in the one case in this series, seen six weeks after injury, and in two cases outside of this series (observed under treatment in adduction



FIG. 1b.—Skiagraph of FIG. 1a, taken August 1, 1923, four weeks after injury.

and internal rotation), the disability in limitation of abduction, external rotation and loss of power persisted for months. This fracture should be recognized as a major injury in the disability it produces and due treatment accorded it. It has become our custom to give it the same care in suspension, abduction and external rotation which we give the apparently more important injuries about the shoulder.

Fracture of the lesser tuberosity alone has been encountered in two cases. In each case the fracture accompanied a posterior or subspinous dislocation of the head of the humerus. Both cases were admitted to our division since October, 1923, and are apparently the only cases seen in Bellevue in several

years. The mechanism of production of this injury affords an opportunity for interesting conjecture, but it is unfortunate that in both the cases here mentioned history was indefinite and undependable. One was alcoholic and admitted six days after injury; one was psychopathic and admitted eight to twelve days after injury. In each case the fractured lesser tuberosity was displaced well down alongside the rim of the glenoid cavity and remained in this position of displacement after reduction of the head. In one case open operation was necessary for reduction of the dislocation; in the second case

a closed reduction was successful. These two cases will be the subject of an independent report.

The remaining sixty-four fractures of this series involved the surgical neck of the humerus. Thirteen showed slight or no displacement. In this group are placed all those fractures usually diagnosed as impacted fractures of the neck of the humerus. If by this term we mean a simple interlacing of small cancellous irregularities on the fractured surfaces which tends to minimize abnormal mobility, I heartily agree with this term. I would equally disagree, however, with any interpretation of this term in connection with the neck of the humerus

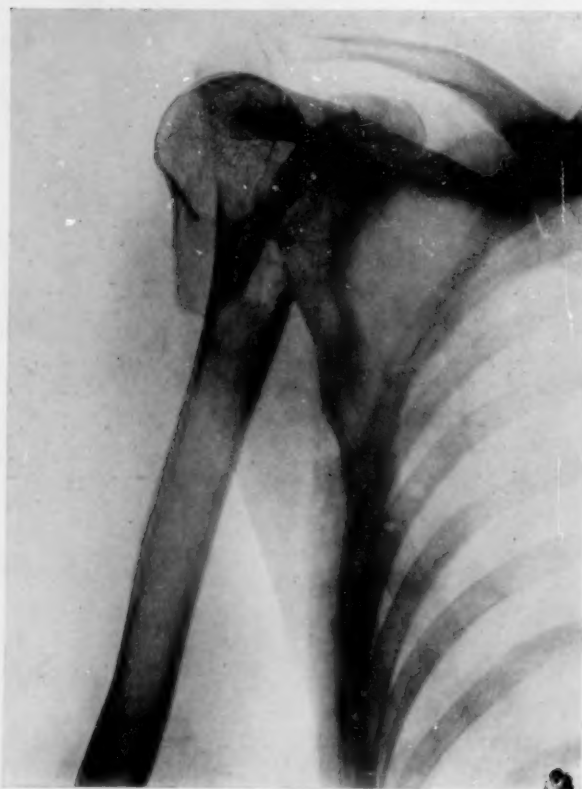


FIG. 2a.—Low fracture of the surgical neck of the humerus with median displacement of shaft. Condition on admission. October 11, 1922.

which conveys the idea of a "jamming together" with true shortening or which conveys the idea that manipulation may not easily displace these fragments. A careful study of these cases bears me out in this, and I think we should consider impacted fracture of the neck of the humerus as rare. Fracture with slight or no displacement would be a better term.

Thirty-one fractures of the surgical neck showed gross displacement with a single line of fracture. (Figs. 2 and 3, a and b.) Seventeen additional cases combined more or less comminution with fracture of the greater tuberosity as well. All showed gross displacement. The level of fracture in these cases ranged from old epiphyseal line to the insertions of pectoralis major and latis-

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simus dorsi. The displacement accompanying these severe fractures of the surgical neck so often follows a definite type that it would seem fair to class as typical of this group of fractures the following position of the fragments—abduction and external rotation of the upper fragment with inward and upward displacement of the lower fragment. Frequently this latter displacement is of such degree that the upper end of the shaft is in a subglenoid or subcoracoid position. In this series such typical displacement varying, of course, in degree, has been present in forty-two of these forty-eight cases. This displacement is due apparently to two factors: First, the lateral displacement due to the continued action of the fracturing violence; second, the longitudinal and rotatory displacement due to muscle action on the two fragments. The presence of this displacement must be considered of importance in the treatment of the fracture and the difficulties it presents in such treatment will be emphasized under such heading.

Three cases combined fracture of the surgical neck with gross displacement and dislocation of the head. One in 1917 was resected early; no records are available after his discharge from the hospital. One showed an anterior, partially subglenoid, position of the head with fracture through the neck and through the greater tuberosity, the latter displaced upward and outward. This fracture was treated by abduction and external rotation. At the end of two months open operation for reduction of the dislocation was done. Reduction was easy, but it could not be maintained as capsule and subscapularis offered no opportunity for good suture. His result was practically entire loss of shoulder joint action and almost all motion scapular. The third case was a partial subglenoid dislocation accompanying fracture through the surgical neck. She was admitted promptly after injury, placed in frame for her fracture, but the



FIG. 2b.—Low fracture of the surgical neck of the humerus with median displacement of the shaft. Condition on November 8, 1922, five weeks after injury.

partial dislocation was overlooked. She had a poor result and well emphasizes the necessity for continuous close supervision over all these cases.

*Treatment.*—The early cases of this series have been through practically every recognized type of treatment for this injury. Although Case I followed very shortly the publication of Doctor Blake's article in the Archives de Medicine et de Pharmacologie Militaire in Paris, in 1916, and was treated by suspension, abduction and external rotation, traction was not made in sufficient degree to overcome the subglenoid position of the upper end of the



FIG. 3a.—Fracture of the surgical neck of the humerus, complicated by long spiral fracture of the upper shaft of the same bone. Condition when admitted, March 20, 1923.

shaft, and after three weeks he was subjected to anaesthesia and traction on the Hawley table with plaster spica. Only angulation at the site of fracture resulted. After forty-eight hours, abduction to 45 degrees, suspension and traction were again used—too late, however, for good anatomical alignment. His result, however, as to function was good; at the end of five months abduction was perfect, external rotation good, internal rotation poor in that he could not reach his back. Following this case, the shoulder cap with weight extension, plaster spicas, Middledorpf triangle, aeroplane splints were all used, mainly, however, after suspension, traction

abduction for the first ten to seventeen days. That this haste to ambulate many of these cases in fixed adduction defeated the advantages of the initial treatment is obvious. In the last fifty cases of this series where any mechanical treatment at all was thought advisable, only suspension, abduction, traction and external rotation have been used, the various elements in this combination varying according to indications. The advantages of this method of treatment were so clearly and ably demonstrated by Dr. Kenneth Bulkley and Dr. James N. Worcester on our division that its use has now become practically routine with us. The technic and details of application of this treatment have become so familiar to those interested in major fractures, and so much has been published



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illustrating the overhead frame for suspension and the various points for obtaining traction in fair anatomical alignment that further discussion on these details seem superfluous. Certain conclusions as to applicability, however, may well drawn and emphasis on certain details may well be justified.

There is one optimum position in which practically all fractures about the neck of the humerus should complete their union and this position is one of *wide abduction and external rotation*. This conclusion is based not only upon a consideration of the bone displacement which attends the great majority of these fractures, but also with greater emphasis upon a consideration of the injury to capsule, muscle and muscle attachments which must accompany every such fracture. Anatomically the shoulder joint sacrifices a certain amount of security to obtain its marked physiological range of motion. A redundancy of capsule at the inferior portion is necessary to permit of wide abduction. This redundancy in the adducted position is probably the source of a certain amount of post-traumatic intracapsular adhesion. The capsule is attached on the antero-inferior aspect not only along the anatomical neck where anatomical



FIG. 3b.—Condition April 15, 1923.

and surgical necks merge, but also somewhat down the shaft. The subscapularis flattens over this capsule in front and sends some fibres of insertion into it before proceeding to its main one and one-half inch insertion into lesser tuberosity and just below. Above and posteriorly, supra- and infraspinatus and teres minor send fibres to the capsule before being inserted from the greater tuberosity downward over the greater width of the surgical neck. Add to this visualization of the soft structures about the neck and tuberosities a direct violence to this region implicating the deltoid and sufficient to cause fracture in a patient over fifty years of age, and we have present all the elements requisite for a prolonged disability. It is our function to shorten this disability in so far as we may and if possible to relieve it entirely.

This disability manifests itself as a rule in three directions—limitation in abduction and rotation and loss of power. The severity of the disability is frequently out of all proportion to the apparent severity of the fracture as in the isolated fractures of the greater tuberosity. Recognizing all these fractures as potential sources of serious disability, treatment should aim toward good functional results in as short a period as possible. We feel that suspension and traction with abduction and rotation do this. The attendant hospitalization for approximately one month seems to be time well spent. In this series it has been free from any untoward complications. It is a type of treatment that tends to maintain fair circulation in the fractured limb, promotes early and fair alignment of the fractured fragments, and what seems most important of all, takes into maximum consideration the associated injuries of the soft parts and places such parts in a position in which recovery is hastened.

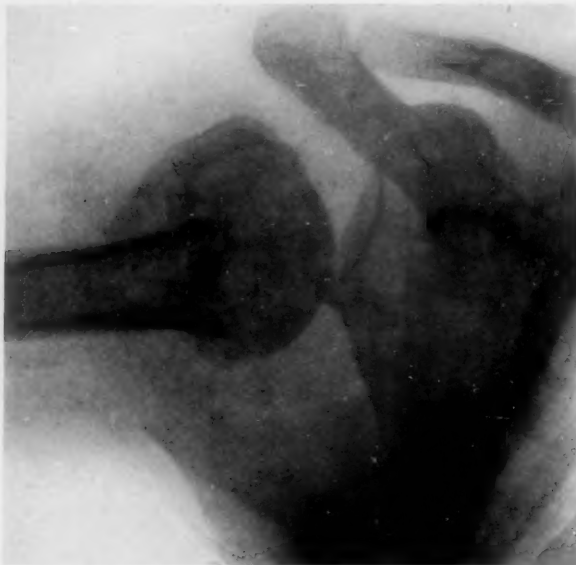


FIG. 4.—Fracture dislocation. Late operation for reduction of dislocation unsuccessful.

The practical use of this method as a routine, however, shows a large number of fractures of the neck of the humerus in whom immediate abduction to 90 degrees is contra-indicated in that angulation will occur at the site of fracture. Such angulation may result in some of the fractures with slight or almost no displacement; it is almost sure to result in those types where the upper end of the shaft is grossly displaced internally. Muscle spasm in pectoralis major particularly, possibly in latissimus and teres major, probably plays the major rôle in this angulation. Although wide abduction and external rotation is the desirable position for this group to convalesce in, its attainment must be postponed for the first few days. Usually traction in the slightly abducted position for a few days will be necessary with perhaps a little lateral traction on the shaft of the humerus. As muscle spasm is overcome and fractured surfaces become sufficiently adherent, it is then possible to gradually increase abduction to the optimum position, reaching 90 degrees abduction by the end of seven to ten days. A delay in the recognition of this principle in a number of our cases led to their convalescence in the moderately abducted position. This apparently delayed the recovery of function in some of these cases.

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Arbitrarily we have accepted about four weeks as the time limit for fractures about the neck of the humerus to remain in suspension. They are then allowed up and encouraged to begin immediate active exercise of the shoulder joint by facing the wall, and with fingers flat against it, crawling up the wall after the manner of a measuring worm. As maximum elevation is reached, the body is turned so that the arm is externally rotated as well as abducted. While this combines a certain amount of passive with active motion, the extent of movement at first is never beyond the point at which the patient has been suspended previously. In fact, as a rule, this point of previous suspension is the mark toward which he aims for several days. Light massage and physiotherapy are not overlooked, but in the minds of many patients they are accorded undue importance and are considered the end instead of the means to the end. Coöperation and real work on the part of the patient are absolute essentials to a steady progressive increase in function and strength. Lacking these essentials the patient may undo in a short time the work of several weeks



FIG. 5.—Fracture dislocation. Operation. Final result. All motion scapular.

by adopting a policy of inaction and immobilization in a sling or bandage.

*Results.*—Any tabulation of results in a series of fractures about the shoulder where joint action itself is so well coöordinated with scapular and sternoclavicular action necessarily involves the personal equation so much that such tabulation becomes valueless unless some arbitrary standard of comparison is adopted on which to base judgment. I know of no well-worked out physiological scale for such comparison. Even abduction which the majority will consider most easy of measurement will vary under different observers from 10 degrees to almost 90 degrees. One observer will measure simply with his eye, another may take pains to measure with the angle of the scapula firmly grasped between the fingers. External and internal rotation are similarly difficult or even more difficult to check up. Good function in external rotation may be at the expense of some function in internal rotation.

However subject as they are to a large percentage of error in interpretation as well as to a certain degree of variation in the individual patient, the results in this series have been measured by the following scale:

Abduction—measured in degrees with digital fixation of angle of scapula.

External rotation in abducted position with forearm flexed—good if latter moves up to or beyond the plane of the body.

External rotation in adducted position with forearm flexed—good if 20 degrees or more beyond the sagittal plane.

Internal rotation in abducted position with forearm flexed—good if 45 degrees or more below the horizontal.

Such a basis roughly makes good external rotation reach to the back of the head and good internal rotation reach to the sacroiliac region of the same side.

Of the five isolated fractures of the greater tuberosity, four treated in hospital were discharged within from three and one-half to five weeks with 75 degrees or more abduction, good external rotation but poor internal rotation. In two followed up, four months and two



FIG. 6.—Fracture dislocation. Operation. Final result. All motion scapular.

months longer were necessary for internal rotation to become good; abduction at this time was 90 degrees. The one case seen six weeks after injury continued a disability for over ten months.

Of the fractures of the surgical neck with little or no displacement, six were followed to the final result. One (age thirteen) treated initially in Sayre strapping showed excellent function in three months; one (age seventy-one) treated simply by abduction and external rotation on pillows showed excellent function, except for strength, in four weeks. Three cases suspended

# FRACTURES UPPER END OF HUMERUS

in apparatus showed good function in eight weeks (age thirty-six), nine weeks (age seventeen), three months (age fifty). One (age seventy) showed good function on discharge in thirty-five days, only fair function after four months, abducted only 45 degrees with soft joint crepitation after one year. Rotation, however, was good.

The fractures of the surgical neck with gross displacement were all treated in suspension. The final notes in nineteen cases follow:

Age	Time of note	Abduction	Rotation		Remarks
			External	Internal	
1. 42	5 Months	90 Degrees	Fair	Fair	Poor anatomical result
	9 Months	90 Degrees	Good	Good	
2. 40	2 Months	50 Degrees	Fair	Fair	
3. 70	6 Weeks	85 Degrees	Poor	Poor	Bad comminution
	10 Months	70 Degrees	Poor	Poor	
	3 Years	30 Degrees	Almost none		
4. 40	4 Months	90 Degrees	Good	Good	Waitress
5. 50	2 Months	90 Degrees	Good	Good	Strength—(minus)
6. 50	6 Months	90 Degrees	Good	Good	
7. 58	6 Months	90 Degrees	Good	Good	
8. 60	8 Months	90 Degrees	Good	Good	
9. 39	2 Months	90 Degrees	Good	Good	
10. 58	6 Weeks	90 Degrees	Good	Good	Strength—(minus)
11. 41	5 Months	80 Degrees	Good	Good	
12. 49	2 Months	90 Degrees	Good	Good	
13. 54	3 Months	90 Degrees	Good	Good	
14. 44	3 Months	90 Degrees	Good	Good	Strength—working
15. 57	4 Months	90 Degrees	Good	Good	Strength—working
16. 49	5 Months	90 Degrees	Good	Good	
17. 32	9 Weeks	90 Degrees	Good	Good	Working
18. 70	3 Months	75 Degrees	Good	Fair	
19. 54	3 Months	All motion	scapular		Dislocation—Operation refused

Of these nineteen cases, fifteen had good functioning shoulders within two to nine months, thirteen of these within five months. Two had only fair function at the end of two and three months, respectively, when their last notes were made. Two were distinct failures as to function, one a badly comminuted fracture of head and greater tuberosity, one an unreduced partial dislocation in whom fracture healed well anatomically.

Six cases in this series were operated on. No case was subject to operation except on indications which seemed to permit of no other procedure. Such indications were (a) complicating dislocations not reducible, (b) gross displacements or comminution of head where no apparent contact between fractured surfaces could be established. The operations done included two excisions of the head through the surgical neck, one simple removal of head dislocated through capsule, one open reduction of a posterior dislocation in which lesser tuberosity was fractured, one instrumental manipulation of a rotated head and greater tuberosity to establish alignment, one late reduction



of subglenoid dislocation after union of fracture with unsuccessful plastic on capsule. The operations were all done rather late after all other means had failed. Perhaps this was an error in judgment. The results have been uniformly discouraging. (Fig. 5.) Of five followed, four have practically no joint action. One excision at the end of three months had normal passive motion, very little active. He looked encouraging but has not been seen since. In fact, the end results in these cases have been little different from analogous types of cases in whom no operation was done.

#### SUMMARY

In conclusion certain broad, general deductions based upon the above series may be permitted me.

Fractures about the neck of the humerus occur mostly beyond mid life. The resulting disability is usually marked and prolonged. It is done mainly to the associated injury of soft tissues about the site of fracture. Wide abduction and external rotation is the position of choice for convalescence. Such position in a number of cases must be attained gradually. While recognizing the value of various types of ambulatory splints, I feel that the conditions



FIG. 7.—Fracture dislocation. Operation. Final result. All motion scapular.

here encountered are best and most comfortably met by bed and traction suspension treatment with a frame. Massage and physiotherapy are aids in treatment, but the best and quickest results reward the coöperative, intelligently active patient. For this reason women who resume their household duties early seem to regain function and strength more rapidly than men.

I wish to express to Dr. John A. Hartwell, Director of the Second Surgical Division, my appreciation of the privilege of reporting the above cases and also my appreciation to the changing but ever conscientious members of the House Staff who do so much of the work in such a series.

## IDIOPATHIC OSTEOPSATHYROSIS\*

(FRAGILITAS OSSIIUM)

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IDIOPATHIC osteopsathyrosis is a definite and distinct disease entity. Its differentiation from other bone diseases may be made with certainty from the history alone. In no other disease are there numerous and repeated fractures resulting from insignificant trauma and occurring throughout entire life of individual.

In osteopsathyrosis the long bones are most frequently the site of the predominating feature—fracture. The linear development of the bony skeleton is usually normal, but the height of the individual is shortened by the bowing and angulation of the long bones, incident to their repeated fracture and faulty union. The epiphyses are not enlarged; the diaphyses are originally straight and cylindrical but soon become bowed and flattened, most frequently in the antero-posterior diameter.

Bone fragility, in this disease, is not due to an insufficiency of the inorganic chemical constituents, since on analysis of psathyrotic bone these constituents are found to be quantitatively normal.

It is to morphological defects in the bony framework, producing mechanical instability, that the characteristics of osteopsathyrosis must be ascribed. These defects consist of a thinned porous cortex, the continuity of which is often interrupted, and the presence, within the medullary cavity, of isolated areas of new bone. The absence of fibrous tissue renders these bones inelastic. Their strength is impaired by the loss of their normal tubular structure.



FIG. 1.—Idiopathic osteopsathyrosis (fragilitas ossium) from the orthopaedic wards of the Philadelphia General Hospital, W. J., age thirty-eight.

\* Read before the Philadelphia Academy of Surgery, February 4, 1924.

Etiologically, osteopsathyrosis is independent of any luetic or other infectious origin. Locke<sup>5</sup> believes with Harbitz<sup>28</sup> that during foetal life there is some nutritional disturbance which affects the entire bony system. Voorhoeve<sup>30</sup> attributes the development of this disease to a hereditary inferiority of the mesenchyme. The possibility of an endocrine disturbance as a primary cause cannot, as yet, be discarded.

Extensive research by many workers has proven that a familial predis-

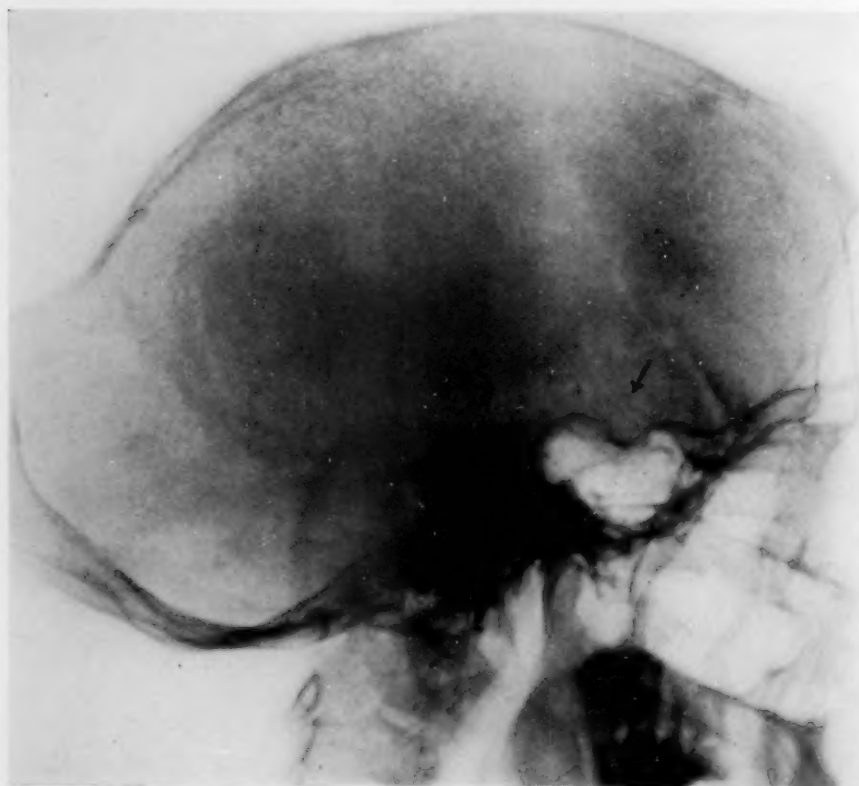


FIG. 2.—Röntgenogram of skull showing distortion of the cranial outline, diffuse areas of rarefaction, indistinct suture lines, extremely small sella turcica, undemonstrable clinoids and large sphenoidal sinuses.

position to osteopsathyrosis (IV) exists. The frequent coëxistence of blue scleræ (V) and impaired hearing with this disease has been established. Blegvad and Haxthausen<sup>32</sup> believe the blue scleræ to be a dominant characteristic under the Law of Mendel. Gurlt<sup>34</sup> considers that the tendency to fracture is transmitted to males through unaffected females; more recent work does not bear out this opinion.

W. J. was admitted to the service of Dr. J. T. Rugh on the first of September, 1923. He was suffering from an acute fracture of the middle third of the left femur with marked displacement of both fragments.

From earliest childhood the patient has been subject, on the slightest trauma, to fracture of the long bones. The left tibia and fibula have been fractured twelve times;

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the right, six; the left femur, six; its fellow, five. The left ulna and radius have been fractured nine times, the right, seven. The ribs, metacarpals and metatarsals have been fractured on numerous occasions. There is no history of fracture of the skull nor of either humerus.

There is no history of previous illness other than measles and an occasional "cold."

The patient's father died of "kidney trouble"; a sister, at the age of twenty, of pneumonia; a brother, of typhoid fever at twenty-four. The mother is living and well; there are no other children; there is no history of miscarriages or stillbirths. In no member of the immediate or remote family is there any history of bone disease or blue sclerae.

The patient has never been married, has always been of good habits, and has lived his entire life at home.

The patient is a grotesque, dwarfed, and misshapen negro (Fig. 1), thirty-eight years of age. He is fifty-two inches tall and weighs seventy pounds.

The head is fringed with black kinky hair interspersed with white. The occipital and temporal protuberances are prominent, while the forehead is high. The occipito-mental diameter is 21.0 cm., while the occipitofrontal is 19.2 cm., the bitemporal 16.0 cm., and the cranial circumference is 55.0 cm. The occipital prominence protrudes abruptly 1.9 cm. beyond a normal contour (Fig. 2).

The ears are free from gross abnormalities, but the hearing is impaired.

The eyes are prominent and protrude 3 mm. beyond normal without increase of intra-ocular pressure. There is complete bilateral arcus senilis with beginning opacity of the periphery of both lenses. Sight is decreased to O.D. 6/25, O.S. 6/25. The pupils are equal and regular and react promptly to light and accommodation. The eye grounds are normal. There are neither extraocular palsies nor nystagmoid movements. The sclerae have a pronounced and evenly distributed bluish color.

Lips, tongue, and mucous membranes of the mouth present no abnormalities; the teeth are firm and even.

The neck is free from adenopathy, while the thyroid is barely palpable.

The chest is funnel-shaped, with a suggestion of a rachitic rosary. The cylindrical thoracic cage tapers abruptly to its junction with the abdomen. The heart and lungs are normal. The systolic blood-pressure averages 100; the diastolic, 58. The pulse ranges between 100 and 120.

The abdomen is small, muscular, and rotund, and terminates in a tilted, flattened,



FIG. 3.—Röntgenogram of femora showing recent fracture of the left femur with displacement of the fragments. The thin, shell-like cortex and rarefied diaphyses characteristic of osteopsathyrosis are apparent in this plate.

pelvis. A marked left dorsal scoliosis and a pronounced lumbar lordosis distort the spinal column. The genitalia are underdeveloped.

There is bowing of both humeri and posterior luxation of both ulnæ. The femora are bowed laterally and the left is the site of a recent fracture in its middle third (Fig. 3). The right leg is comparatively straight. The left tibia and fibula are angulated laterally to ninety degrees in their middle third, so that the long axis of the foot is parallel to the normal axis of the leg (Fig. 4). The hands and feet are twisted and gnarled and

have large callosities over their proximal phalangeal joints. The rotary movements of the forearms and the finer movements of the hands are impaired.

The urine is acid, with a specific gravity of 1023, and is without casts, albumen, or sugar; it is also free from acetone, indican, and Bence-Jones protein.

The blood shows a hæmoglobin of 95 per cent.; the erythrocytes number 5,650,000; the leucocytes, 11,600, of which 62 per cent. are polymorphonuclears, 36 per cent. small lymphocytes, and 1 per cent. each are eosinophiles and basophiles. It contains, per hundred cubic centimetres, 80 mg. of sugar, 12 mg. of urea nitrogen, and 3.6 mg. of uric acid, while the blood plasma contains 10.9 mg. of calcium and 3.2 mg. of phosphorus.

The blood Wassermann is negative in both the cholesterolin and Noguchi antigens.

On admission, the basal metabolism showed a rate of plus 46, but after two months' enforced rest, it fell to plus 23.



FIG. 4.—Röntgenogram of legs showing acute angulation of the left tibia and fibula. The left tibia and fibula are fused in their middle third at the site of repeated fracture and marked rarefaction. The right tibia and fibula are joined by a bony bridge. The fibula has been fractured at the point of contact and is extremely thin. Arrow marks the site of amputation.

Believing that it would be to the betterment of the patient if the useless left leg and foot were replaced by an artificial limb, the leg was amputated 6 cm. below the knee-joint. The operation was performed by Dr. J. T. Rugh under ether anaesthesia. Cross-sections of the tibial shaft were selected for chemical and histological examination from a point not previously the site of fracture. Cultures were immediately made of the bone, the marrow cavity, and the surrounding tissues. These cultures proved to be free from bacterial growth.

The cross-section of the tibial shaft submitted for chemical analysis weighed 9.46 gm. and contained 76 per cent. of dry matter, of which 38 per cent. was ash. The averages of two analyses of the ash gave 18.205 per cent. phosphorus; 38.39 per cent. calcium and 0.615 per cent. magnesium. These analyses were made by Mr. Herman L. Hinski of the Biochemical Laboratory of The Wistar Institute of Anatomy and Biology.

Grossly, the fresh specimen of psathyrotic bone was spongy in appearance, the peri-



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osteum ragged, the cortex thin and friable, the marrow soft, oedematous, and mushy. The histological examination showed that the periosteum was slightly thickened, but in general presented a normal structural appearance. Its outer layer was densely fibrous, its inner portion somewhat more cellular and vascular. The intimal coats of a few small arteries were thickened. The osteogenetic layer was inconspicuous and appeared unproductive.

The cortex did not form a continuous ring, but was broken into large and small segments. These showed marked distortion of the Haversian canals and concentric lamellae.

Thus many canals were extraordinarily large and appeared to be filled with a narrow substance. On the contrary, other canals were small, narrow, and apparently compressed. The vessel walls were frequently thickened and partly hyalinized. The bone corpuscles were often small, shrivelled and numerically decreased.

The bulk of the section, as shown by the photomicrographs (Figs. 6 and 7), was composed of loosely arranged bony trabeculae which simulated spongy bone and branched throughout the medullary cavity. These trabeculae intermingled with the islands of compact bone. Between them were irregular marrow spaces occupied by a delicate stroma which contained eosin-staining structureless substances (oedematous material), fat cells, moderate numbers of round cells and many small blood-vessels. These vessels were, for the most part, capillaries, but here and there arteries with thickened intimal coats could be seen. There were no inflammatory cells of any type present. There was no conspicuous overgrowth of connective tissue. Closely approximating the islands of

compact bone were small groups of multicellular osteoclasts. Rows of flattened diminutive osteoblasts clothed the majority of the osseous trabeculae. Only a small number of the osteoblasts presented their typical cuboidal form.

The pathological process, therefore, seems to be of a twofold nature; first and most important, an active bone resorption, associated, secondarily, with a new bone formation throughout the marrow cavity.

A röntgenological examination visualizes the salient structural features of osteopathyrosis. The thinned cortex, the bowing and angulation, the widely disseminated porosity, and the evidence of the remarkable reparative properties of psathyrotic bone are here shown. It is with difficulty that the site of single fractures can later be demonstrated by röntgenograms. Only after several fractures have occurred in the same locality is the normal contour of the bone markedly altered.



FIG. 5.—Cross-section of tibial shaft for microscopic study. In this low-power photomicrograph are discernible the thin, broken cortex, the distended Haversian canals, the trabeculae of new bone in the medullary cavity as described above. (Photomicrograph.)

An analysis of the above case discloses several facts which are of interest in their bearing upon the general phases of osteopsathyrosis, upon the theoretical etiology of the condition and upon the relation of this case to those cases which have been reported in the literature in the past two hundred years.

It is of note that W. J. has been subjected to repeated fractures throughout his life, from earliest childhood to advanced maturity, and there is the strong possibility that his distorted cranium may be due, at least in part, to intra-uterine fracture. There is no evidence that the frequency of fracture is growing less as age advances.

The fact that neither the history, the clinical findings nor the serological tests reveals a luetic taint is of interest in that so many of the reported cases,

purporting to belong to the group of osteopsathyrosis, are either definitely syphilitic, or lues, as a complication, has not been eliminated.

The normal calcium and phosphorus content of the blood plasma and the normal calcium, phosphorus, and magnesium content of the bone disprove, in this case, the theory that a deficiency of these elements is the cause of osteopsathyrosis.

The absence of any type of inflammatory cell in the histological sections, the sterile cultures of the bone and its surrounding tissues, together with the normal temperature curve,



FIG. 6.—Detail of Fig. 5 in higher power. (Photomicrograph.)

are strong evidences, if not actual proof, against the theory of infection.

That there is an increased resorption of bone in osteopsathyrosis and that the normal tubular structure of the diaphyses is destroyed are shown by the microscopic study. And that these may be due, in this case, to a primary disturbance of the endocrine glands is suggested by the high basal metabolism, the pronounced exophthalmus, the palpable thyroid, the mild tachycardia, the underdeveloped genitalia and the shallow pituitary fossa.

In addition to these salient facts the age of this patient is of interest in that few cases reported in the literature have lived as long. It is also interesting to note in this case that there is no history of bone disease or blue sclerae in any other member of the family. Finally, it may be mentioned that despite his frequent fractures, this patient was at all times remarkably free from pain.

## IDIOPATHIC OSTEOPSATHYROSIS

### SUMMARY

1. A case of idiopathic osteopsathyrosis (*fragilitas ossium*) occurring in a negro thirty-eight years of age is here reported.
2. The patient has suffered, as the result of slight trauma, approximately forty-five fractures of the long bones.
3. The calcium and phosphorus content of the blood plasma and the calcium, phosphorus and magnesium content of the bone are normal. The basal metabolic rate is increased; there are marked exophthalmus, palpable thyroid, immature genitalia, shallow pituitary fossa, mild tachycardia, blue scleræ and impaired hearing.
4. No history of syphilis, infection or familial predisposition to bony fracture or disease can be elicited. There is no history of blue scleræ in the members of the immediate or remote family.
5. Microscopic examination of the cross-section of the tibial shaft procured by amputation of the left leg shows a broken and thinned cortex, distended Haversian canals, increased bone resorption and new bone formation.
6. Photographs of the patient, röntgenographs of the bony skeleton and photomicrographs of the bone sections are embodied in the paper.

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## SYSTEMIC BLASTOMYCOSIS (OIDIOMYCOSIS)

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IN 1894, Gilchrist<sup>1</sup> described before the American Dermatological Society, a yeast-like organism which he found in a section taken from a patient with an unusual dermatitis. He classified the organisms as blastomycetes and named the disease blastomycetic dermatitis. A few months later, Busse<sup>2</sup> described a fatal case and demonstrated the pathogenicity by finding the organism in the internal organs as well as in the skin. He termed the disease saccharomycosis hominis. The bacteriological and clinical features of these two cases are quite identical with those subsequently reported by various men as blastomycosis or oidiomycosis.

The following case is described as a fatal case of the systemic disease, and is unusual because of the small amount of pathology found in comparison to the symptoms.

*Clinical History.*—A. B. S., age twenty-seven, male, American. First admission March 28, 1922. Discharged May 26, 1922. Admitted again January 3, 1923. Died March 7, 1923.

There was nothing of interest in his family history. He denied luetic infection, but admitted gonorrhœa four years previously. For two years prior to admission he had been employed as a miner in an Illinois coal mine. The onset of his disease dated back to March, 1921, (a year before admission) when he mashed the fourth finger of his right hand. The resulting injury remained a granulating ulcer for 10 months. A few weeks after this injury he became aware of pain in his lumbar spine. Two months after onset of his lumbar pain, he noticed a fluctuating lump in his lumbar region, which was incised and had drained continuously up until admission. A few weeks after incision of this abscess there developed skin lesions, in order of appearance, on the back of his neck, over the right shoulder, on the left buttock and on the right leg.

November, 1921, patient developed a cough which gradually increased in severity, and which was productive of a blood-stained, muco-purulent, grayish-brown sputum. Associated with this he had a definite but slight shortness of breath, but scarcely any pain. About March 5, 1922, (three weeks prior to first admission) he developed a soft fluctuating mass over his right jaw. At about the same time his scrotum began to swell, and two weeks later a sinus developed on the right side. He had lost about 30 pounds of weight since the onset of his disease, and was bedridden at the time of admission.

*Physical Examination.*—The patient is a well developed, but moderately emaciated and anemic middle aged man. Over the occipital region, left scapular region, left posterior thorax and right buttock are skin lesions varying from 8 to 16 cm. in diameter (Fig. 1). Each lesion has a red irregular cauliflower-like surface, which bleeds readily. The base is reddened and elevated. The centre

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of some lesions show scarring of recent healing. Mild discharge, but no deep ulceration is present. Fresh lesions first show up as small papules or pustules which later coalesce to form the cauliflower-like mass.

Just to the left of the spine of the 5th lumbar vertebra is a mass of granulations (2 cm. in diameter) with a draining sinus in the centre. Within one to two cm. of the edges of the various lesions are tiny miliary abscesses, some of which can scarcely be seen with the naked eye (Fig. 2).

Over the ramus of the right jaw and adjacent tissue is a tense, smooth fluctuant



FIG. 1.—Appearance of skin lesions on neck and shoulder at time of first admission before treatment was started.

mass 5 x 8 x 10 cm. Pus is present and feels superficial. Only slight tenderness is present. On account of this abscess, he is not able to open his jaws more than 1 cm. Below the above mass is a nodular mass suggesting numerous small lymph glands matted together.

Respiratory excursion of the right side of the thorax is distinctly less than the left. Breath sounds are harsh over the right upper lung, where the percussion note is impaired. A few crepitant râles are heard here and at each base.

The liver is palpable 5 cm. below the costal margin and is very tender. The splenic dullness is increased.

There is a discharging sinus over the right epididymis which is 5 cm. in diameter, firm and tender.

A recently healed ulcer is noted on tip of the fourth finger of the right hand at the site of his initial lesion. Definite but slight tenderness is made out over the spines of the 3rd and 4th lumbar vertebrae.

*Laboratory Data.*—Erythrocytes, 4,600,000. Leucocytes, 12,000 to 25,000. Haemoglobin, 80 per cent. Differential count: Polymorphonuclear neutrophils 60 per cent. Lymphocytes, 35 per cent. Large mononuclears, 3 per cent. Eosinophiles, 2 per cent.

Phenolsulphonephthalein kidney test 75 per cent. in 2 hours. Blood Wassermann

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negative. Sputum:—Consistently negative for tubercle bacilli. Complement fixation for tuberculosis negative.

Urine: Faint trace of albumin. Few white blood cells, no red blood cells. Few granular casts.

Blood culture negative. Culture of aspirated pus from abscess of jaw, hemolytic streptococcus. Culture from miliary abscess of neck, blastomyces.\*

Stool: Red blood cells found during attacks of diarrhoea. Benzidin consistently positive. Frequent yeast-like organisms, having a double contoured surface, which, however, could not be established definitely as blastomyces.

X-ray studies of the gastro-intestinal tract were made by Doctor Mills who



FIG. 2.—Skin lesion on buttock before institution of treatment.

reported an unusual gastritis, characterized by massive gastric *rougæ*.

*Course During First Admission.*—(March 28, 1922, to May 26, 1922). The patient's temperature persisted irregularly around 100°. Pulse 90 to 110. The abscess of the jaw, was incised shortly after admission, and thin greenish pus obtained. The abscess cavity healed very slowly. He was put on intensive potassium iodide treatment, and was able to tolerate 150 grains per day. One heavy dose of X-ray therapy was given over two of the lesions, but no difference could be seen in the rapidity of healing. Under iodide treatment, his lesions began to heal remarkably fast, and at the time of his discharge, the cauliflower-like granulations had been replaced by a scaly scar which seemed to progress from the centre outward. Over a period of a few days he complained of intense epigastric pain, but without any signs of peritonitis. He was confined to bed when admitted, but regained his strength rapidly and at the end of four weeks was walking around without discomfort.

*Microscopical and Cultural Characteristic of the Organism.*—Smears were made repeatedly from the various open skin lesions and the sinus over the back,

\*Credit is due Miss Ludwig of the bacteriological laboratory of Barnes Hospital, for assistance with the cultures.

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but only occasionally, could one find unquestionable blastomyces. From the military abscesses, however, smears consistently yielded a moderate number of organisms and produced a pure culture of blastomyces.

On the third or fourth day of incubation tiny colonies of the yeast could be seen on the surface of the media. These colonies were heaped up, wrinkled, had irregular edges and were of a dark gray color. They grew equally well on blood agar and glucose agar, but seemed to produce a heavier and earlier growth on Russel's media than upon any of the others tried. In broth a granular cloudiness developed in five or six days and by the end of twelve days a grayish granular precipitate of the organisms was formed. As the culture on solid media aged, the color of the growth became darker. When the culture tube was sealed, thus restricting air, the organism invariably formed aerial hyphae within three weeks, and in gross appearance greatly resembled a mould.

Microscopically, the organism was seen in tissue only in the budding form. Likewise, the minute colonies obtained by transplant directly from patient to media, consisted almost entirely of budding forms for the first few days. As the culture aged, however, mycelia appeared and became more predominant as successive transplants were made. It was also noted that unfavorable conditions during incubation, such as low temperature or dry media tended to produce more and thinner mycelia threads.

The organism in the budding stage is 8 to 18  $\mu$  in diameter, is round or slightly oval, and is doubly contoured. No nucleus can be definitely identified, but the protoplasm is coarsely granular and contains highly refractile bodies. Occasionally, vacuoles are seen. The terminal or younger mycelial segments are more homogeneous and contain fewer granules. As the culture ages, there is an increasing tendency toward formation of terminal and lateral conidia which are connected to the main stem by short thick pedicles.

The organism produced no gas in either dextrose, lactose or saccharose broth.

*Animal Experiments.*—The organism proved consistently pathogenic to guinea pigs. Five were injected intraperitoneally, all of which died in about four weeks. Organisms were demonstrated either in culture or section in all but the first. A mouse which was injected intraperitoneally died in 24 hours, but no organisms could be found. One rabbit was injected intraperitoneally but showed no evidence of disease. In none of the guinea pigs were tuberculous lesions found.

*Progress Since First Admission.*—On January 3, 1923, seven months after discharge, he was admitted again. He volunteered the information that he had stopped the daily dose of iodide several times, for periods of 2 to 3 weeks, and

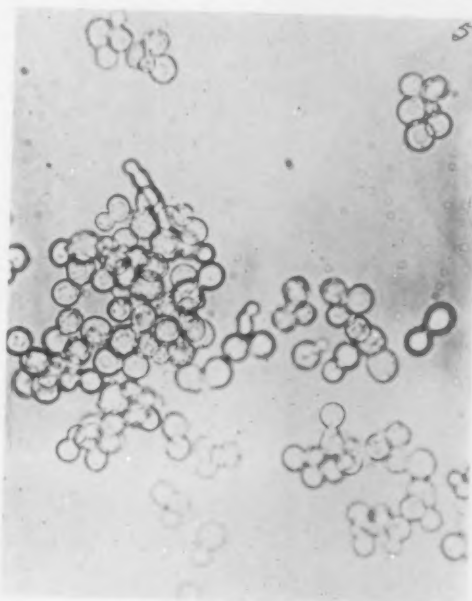


FIG. 3.—Culture four days after transplant from minute abscess to blood agar, showing predominance of budding forms.

had suffered from appearance of new lesions and general ill health. During the last four weeks previous to second admission, he had three convulsions of a generalized type. Two weeks before second entry, his scrotum and ankles began to swell. He had been gradually losing weight.

Examination showed the lesions to be dried but scaly as at discharge of first entry. Scattered over the body were several small fluctuant superficial abscesses, which contained thin greenish pus, in which blastomycetes could be found. The sinus of the epididymis had healed, but the sinus over the 4th lumbar vertebra was still draining. There was marked cedema of the ankles and scrotum, as well as

fluid in his peritoneal cavity. The lung findings remained practically the same.

In addition to heavy doses of potassium iodide by mouth, patient was given several intravenous doses of 50 to 75 grains of sodium iodide. He also received several doses of salvarsan. From none of these procedures did he receive any beneficial effects. He became very weak and died apparently from toxemia on March 7, 1923.

Organisms were again found in his sputum, but were not

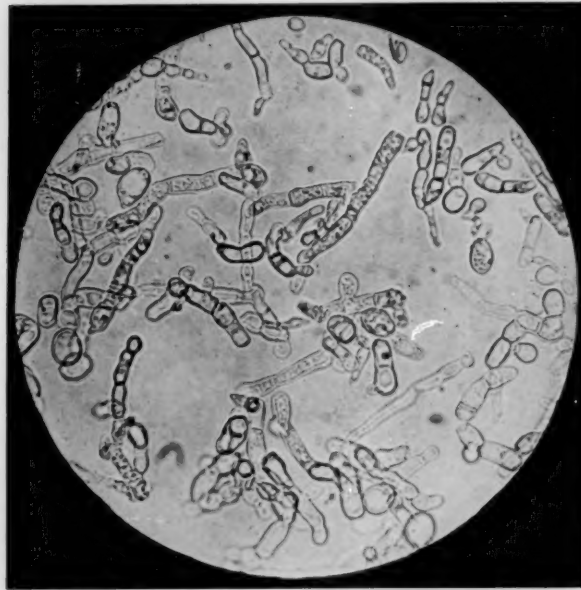


FIG. 4.—Appearance of culture after several transplants. Note predominance of mycelial forms. Occasional terminal and lateral conidia are seen.

demonstrated in the urine as they were on his first admission. His N.P.N. remained normal. Urine gave a very heavy test of albumin and contained many casts, a very few of which were waxy. Blood culture remained negative. Sputum and urine cultures negative for blastomycetes. X-ray of lumbar spine revealed a destruction of the fourth lumbar vertebra, as contrasted to negative bone findings on the last admission.

*Autopsy Report.*—(By Dr. E. S. Walsh). The body is that of a poorly developed and nourished white male weighing fifty-seven kilos and measuring 154 cm. in length.

Numerous foci are scattered over the body surface in the skin. Possibly the largest is situated over the right scapula; another very large one over the left tibial region. Small suppurating lesions are seen in both groins and over the right scapulo-humeral joint. Pressure on any of these lesions yields a thick creamy pus. The general character of all the lesions is much the same in that there is an elevated nodular periphery with a smooth scar-like centre. Crusts are heaped up in places, and over the suppurating lesions the skin is so thin in places that slight pressure causes rupture with discharge of thick creamy pus. The skin of the scrotum is greatly thickened and indurated and several excoriated areas are seen upon it.



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On opening the head a rather noticeable engorgement of the vessels of the pia arachnoid is seen and there is some œdema.

There are about 2000 c.c. of cloudy fluid in the peritoneal sac. This does not coagulate on standing, but fibrin shreds are present in considerable numbers.

The pericardial sac also contains some cloudy fluid and there is a white scar in the epicardium of the right auricle.

The heart weighs 220 gms. and the valves measure as follows:

A	7.00 cm.	M	10.0 cm.
P	8.0 cm.	T	11.0 cm.

The left ventricular wall measures 12 mm., the right 5 mm. The myocardium is of a deep red color. The heart is dilated with fluid and clotted blood.

The lungs do not collapse when the chest is opened and the right one is loosely bound to the chest wall by delicate fibrous adhesions. Great numbers of shot-like nodules are scattered throughout all lobes of both lungs. In places these nodules have aggregated themselves to form foci of considerable size (2 to 3 cm. in diameter). On section these lesions are only distinguished with considerable difficulty. The places where large numbers of them have gathered together appear as deep red irregular areas. (Lungs fixed for future study.) There is a fibrous lesion at the right apex.

The liver is large, pale and smooth, and irregular areas of necrosis are scattered throughout. It weighs 2150 gms. and measures 27 x 19 x 8 cm. There are many spots on the cut surface which have a pale waxy appearance. These are stained brown by iodine but not very distinctly. The gall-bladder is greatly distended with fluid bile which can readily be expressed into the duodenum.

The spleen is very large and firm and divided into three lobes by two notches. On section, numerous waxy foci are seen scattered throughout the pulp. These do not seem to bear any definite relation to the Malpighian corpuscles as they are located both within and outside the waxy areas. They are stained brown with iodine. The spleen weighs 530 gms. and measures 15 x 11 x 6.5 cm. Several sharply encapsulated tubercles are found in the pulp and one upon the surface of the organ. The pulp outside of the pale waxy appearing foci is rather bright red in color. The capsule is thickened in several places. In addition to the lesions already described there are many very minute gray opaque areas which have a tendency to occur in clumps. These cannot definitely be differentiated from Malpighian corpuscles.

The pancreas appears normal. It weighs 135 gms. and measures 23 cm. in length.

The right kidney weighs 360 gms., the left 280. One measures 13 x 8 x 4 cm.,

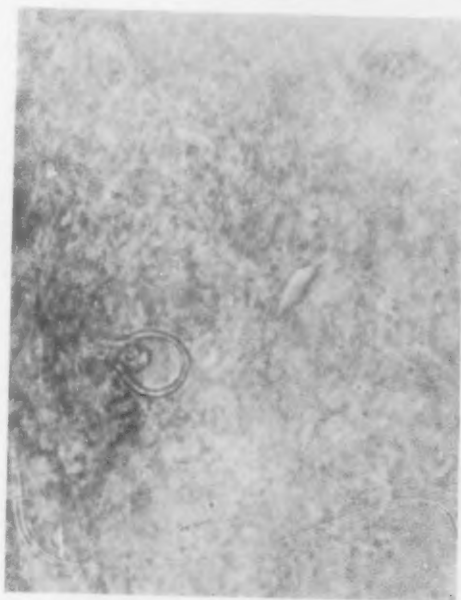


FIG. 5.—High power of a budding organism in the lung of guinea pigs injected intra-peritoneally with the organisms.

cortex 9 mm. They are pale and smooth. The capsules are rather firmly adherent to them and they seem to be very thin. The surface as well as the cut surface is irregularly mottled by small grayish-white opaque areas. The *adrenals* appear normal. The *pelvic organs* appear normal.

*Microscopical Examination.*—*Myocardium* appears normal. *Lung*: The histological appearance is that of tuberculosis with the following exceptions. Small aggregations of polymorphonuclear leucocytes, sharply circumscribed, are frequently seen and often form the nucleus of what otherwise would appear to be typical tubercles. Giant cells of the type usually associated with tubercles are abundantly formed in and around the lesions. Yeast cells are present but in very

scanty numbers, and when found are either in the small polymorphonuclear accumulations or in the giant cells. A few budding forms are found. There is some necrosis but little or none of the dead material has the typical appearance of caseous tuberculous tissue.

*Liver*: A few focal accumulations of mononuclear leucocytes are seen in the periportal areas. The sinusoids are dilated. Amyloid is deposited rather abundantly in the walls of some of the small vessels. The dilatation of sinusoids is most conspicuous at the centre of the lobules and is accompanied by a moderate amount of atrophy of liver cells.

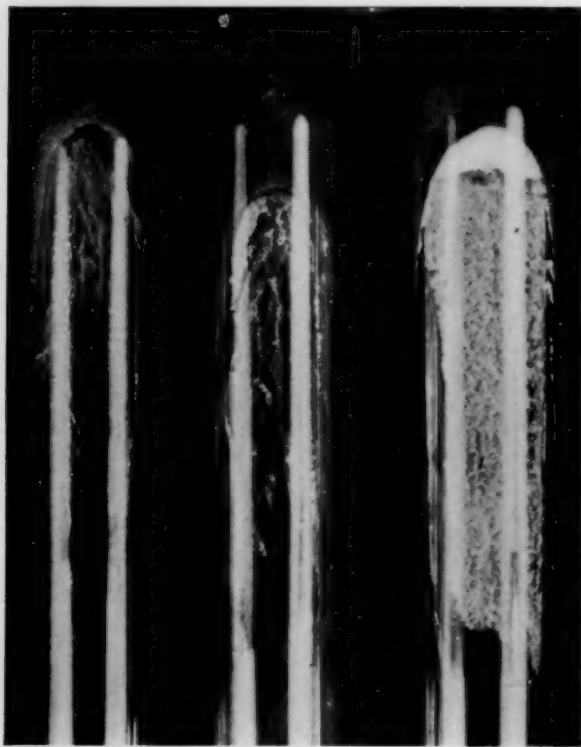


FIG. 6.—Culture two weeks of age. From left to right, glucose agar, Russel's media and blood agar.

The *pancreas* appears normal.

The *spleen* is heavily loaded with amyloid which occurs both in and around the Malpighian corpuscles. In the former case the lymphoid elements of the corpuscle are completely replaced by it. The walls of the small blood-vessels are conspicuously involved.

*Kidney*: There is an abundance of homogeneous material in the glomerular tufts, glomerular vessels, and the walls of many of the larger vessels. This material is stained brown by iodine and red by methyl violet. Hyalin tube casts are frequently seen.

*Adrenal*: Amyloid seems to be abundantly deposited.

*Skin*: There is a marked epithelial hyperplasia with numerous papillary downgrowths into the corium. The surface in many places is ulcerated. The corium likewise is thickened and contains numerous plasma cells. Scattered

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about in the corium, adjacent to the distorted finger-like processes of the epithelial layer, are numerous irregularly shaped islands of epithelium. Throughout the entire section, and especially prominent in the Malpighian layer of the epidermis are numerous minute abscesses of varying size. Some abscesses contain only a half dozen or dozen leucocytes; others are large enough to be visible to the naked eye. A relatively large percentage of the polymorphonuclears are eosinophils. In addition to the polymorphonuclear invasion, there is a diffuse mononuclear infiltration. Throughout the section, especially notable in the miliary abscesses, are a moderate number of giant cells. Typical blastomycetic yeast cells, of a

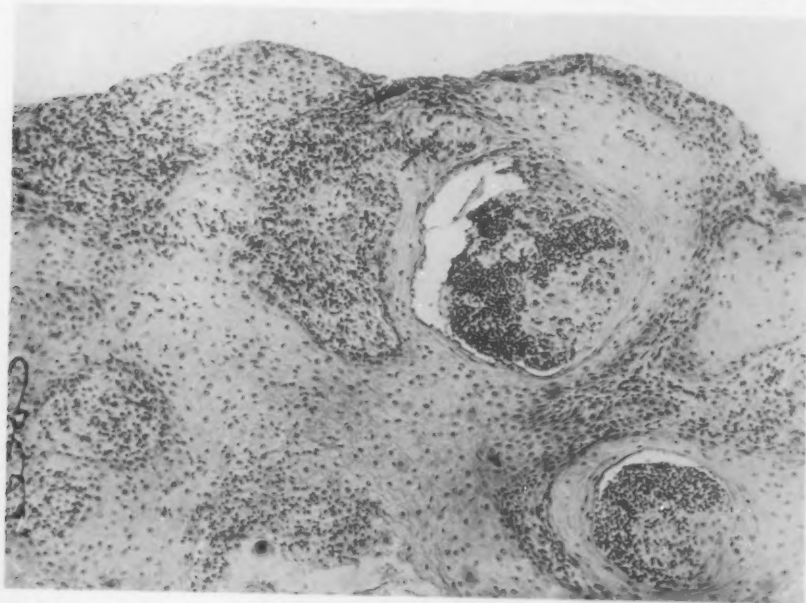


FIG. 7.—Low power of section of patient's skin showing miliary abscesses and hyperplasia of epithelial cells.

description found elsewhere, are seen throughout both layers of skin, usually in the miliary abscesses and frequently in the giant cells.

A set of sections stained with carbol fuchsin and methylene blue are negative for acid fast organisms.

The *brain* upon cut section reveals no abscess cavities or evidence of inflammation. Culture of heart's blood yielded a hæmolytic streptococcus, but no blastomycetes.

*Clinical and Pathological Diagnosis.*—Pulmonary and cutaneous blastomycosis, blastomycosis of 4th lumbar vertebra, general amyloidosis, fibrino-purulent peritonitis, fibrino-purulent pericarditis, œdema and congestion of pia arachnoid, blastomycosis of epididymis (healed), abscess of jaw, secondary anemia and hæmolytic streptococcus septicemia.

*Remarks.*—As stated, the peculiarity of this case is the scarcity of lesions found at autopsy as compared to the clinical symptoms. However, the organs affected, including lungs, bone, skin, and epididymis represent common locations for disease, excepting the latter. From a review of twenty-two autopsied

cases, Wade and Bel<sup>3</sup> found the organs affected in order of frequency were lung, skin, bone, spleen, kidney, liver, lymph-nodes and brain.

The pathology of the lungs on cut section resembled tuberculosis very closely, except as is usually the case in pulmonary blastomycosis, no cavities were found. The exception to this rule is found in a report by Irons and Graham<sup>4</sup> of a case which had cavities in the lung.

*Pathogenicity.*—The portal of entry in this case is undoubtedly through a wound of the finger, sustained in an accident in a coal mine. It seems logical

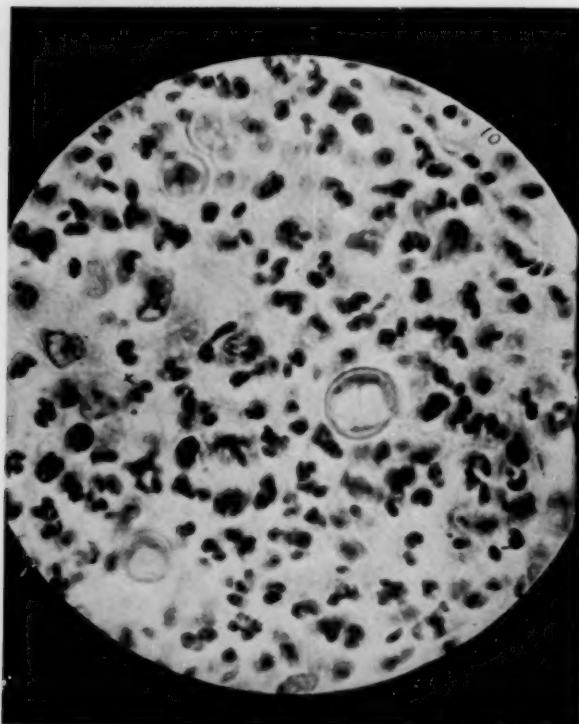


FIG. 8.—High power of a minute abscess containing several organisms. Note the presence of polymorphonuclear leucocytes.

to suppose the mine was the habitat of the organism, but we were unable to obtain history of any similar infection among the miners in this locality. All symptoms of this patient developed after this injury, which produced a stubbornly healing ulcer on his finger. Pulmonary symptoms did not develop until seven or eight months after his initial infection. Study of previously reported cases, however, supports the theory of pulmonary infection as the initial lesion. Montgomery<sup>5</sup> reported a case whose first symptoms were pain in the chest and which at autopsy revealed blastomycotic abscesses in the lungs.

Christensen and Hektoen<sup>6</sup> also report a case whose first symptom was pain in the chest. The majority of cases of systemic disease, however, gave a history of an initial skin infection.

Although frequent recoveries are encountered among the cases whose disease is limited to the skin, the fatality of systemic infection is almost absolute. Herrick,<sup>7</sup> however, reported a recovery from systemic infection. A systemic case under the observation of Boughton and Stober<sup>8</sup> also recovered, but under heavy vaccine therapy. Davis,<sup>9</sup> however, offers evidence of a very poor immunological reaction, but he was dealing with a different strain of the organism. Although the disease is comparatively a rare one, no less than two physicians have suffered an infection by contact with infected patients.

## SYSTEMIC BLASTOMYCOSIS

It is quite certain that the infection is a blood-borne disease even though the primary portal in some cases is the lung. Notwithstanding this certainty, it apparently is very difficult to demonstrate the organism in the blood stream. Krost, Stober and Moes<sup>19</sup> observed one of the few cases from which the organism was obtained by blood culture.

*Differential Diagnosis.*—Undoubtedly, the disease is much older than records show, but was diagnosed wrongly, probably in most cases as verrucous tuberculosis. Most blastomycotic skin lesions develop faster than verrucous tuberculosis. The former will respond to iodide treatment whereas the latter will not. The pathology is very similar to tuberculosis but polymorphonuclear cells are more numerous than in a tubercle, and eosinophils are found in great numbers. The proliferation of epithelium resembles an epithelioma but the miliary abscesses, eosinophils and presence of organisms are distinguishing features. Syphilis rarely simulates it, and can be excluded serologically and by reaction to salvarsan.

*Treatment.*—This particular case was treated with iodides, salvarsan, X-ray and local application of mercurchrome. The beneficial value of the former is unquestioned, and was probably first used by Bevan. None of the others, except the local application of mercurchrome, which did stimulate scarring of the lesion, had any effect. Copper sulphate has been used for years both externally and internally but with very little if any beneficial effect. On account of the relatively slow growth of the local lesions, excision should be, and has proven to be a curative measure many times. Obviously, to be a suitable case for excision the infection must be confined to the skin and be accessible to the knife.

*Classification.*—Curiously, practically every organism reported differs in minor details from all the others. This makes it difficult to establish an accurate nomenclature. All of them, however, might be said to be double contoured yeast-like organisms having no definite nucleus, which reproduce in living animal tissue by budding only, and which under certain varying conditions will produce mycelia. One of the important points of difference between the different organisms reported, lies in animal experimentation. Most strains

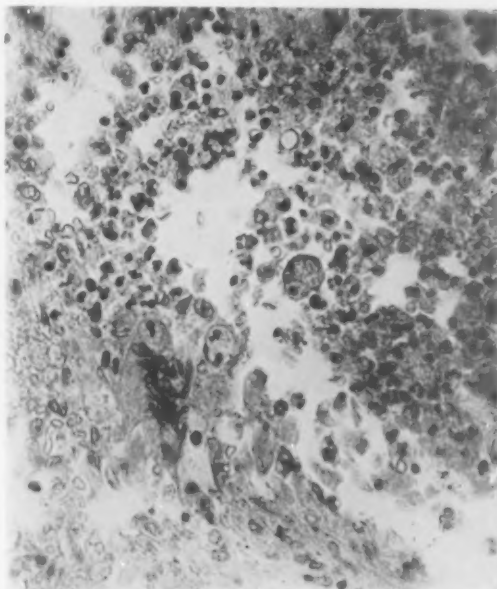


FIG. c.—Moderately high power of miliary abscess containing a budding organism in the lung of the patient.



are pathogenic to guinea pigs, but Eisendrath and Ormsby<sup>11</sup> and many others report negative results from guinea-pig inoculation. An interesting discovery that female guinea-pigs are practically resistant to infection was made by Davis and may in some instances account for negative results.

An organism producing a disease very similar to blastomycosis was described by Rixford and Gilchrist<sup>12</sup> and named *coccidioides immites* on account of a very slight similarity to coccidia. The striking difference between this organism and the blastomycete lies in its reproduction by sporulation. In many cases, it is difficult to determine whether the causative organism is a blastomycete or the coccidioidal organism. The clinical features are very similar to blastomycosis, but the prognosis is even more serious than in blastomycosis.

On account of the varied cultural characteristics, it has been hard to select a terminology which will include all the various strains of blastomycetes. In view of the fact that a true blastomycete reproduces by budding only, I would prefer to classify these organisms as oidia and call the disease oidiomycosis, especially since oidia present at least a few budding forms. Ricketts<sup>13</sup> has very satisfactorily divided them into three groups:

1. Blastomycetoid, reproduces by budding, but may produce mycelia.
2. Oidium-like, form submerged mycelia which break up into chains of "spores." Occasional budding form.
3. Hyphomycetoid, produces serial hyphæ in addition to having characteristics of the first two.

Whitman<sup>14</sup> has very aptly classified all coccidioidal as well as blastomycotic cases as *Zymonema*.

Under any circumstances it is an evident fact that the organisms form a stepping stone between the yeasts and hyphomycetes.

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TRANSACTIONS  
OF THE  
NEW YORK SURGICAL SOCIETY  
AND OF THE  
PHILADELPHIA ACADEMY OF SURGERY

*Joint Meeting Held March 12, 1924*

DR. JOHN H. JOPSON, in the Chair

HYPERNEPHROMA OF THE SUPRARENAL IN CHILDREN

DR. JOHN H. GIBBON said that the most striking feature of suprarenal tumors in children, and often the first to be observed, is precocious sexual development. This is of the hetero-sexual type with little or no somatic change. These tumors are much more frequent in girls than in boys. In 22 cases collected by Hoag (*American Journal of Diseases of Children*, June, 1923), 19 were girls and 3 were boys. Sexual precocity in boys is usually of the homo-sexual type and is due most frequently to tumors of the testes and the pineal gland. Hypernephroma in children, elsewhere than in the suprarenal itself, does not produce precocious sexual development. It is rare to find in these cases any disturbance of the pituitary, pineal, thymus or thyroid gland, nor has there been any reported case of involvement of both suprarenals. The immediate operative mortality is extremely high, complete removal has not been attempted, or has proved impossible in most of the cases, and in no case reported has there been a complete cure.

The above statements in regard to this very distressing condition are illustrated by the following case, which occurred in the Pediatric Service of Dr. E. E. Graham at the Jefferson Hospital.

The patient was a female child of three years, operated upon at the Jefferson Hospital, February 29, 1924. Four months before admission the parents noticed an enlargement of the abdomen and an excessive growth of hair on the pubes, labia, in the axilla and on the back. The hair grew very rapidly and that on the pubes and labia was nearly as marked as in a girl whose menstruation is well established. This growth of hair was followed by marked over-growth of the eye brows and a growth of down on the upper lip and face. The child was of normal intelligence and exhibited no somatic change. There had been no menstruation, the clitoris was markedly hypertrophied, and at operation the uterus and ovaries were found to be infantile, thus illustrating the statement that the precocity is of the hetero-sexual type. There had been no nervous manifestations, although in a number of cases reported, epileptic seizures are noted. There was no enlargement of the thyroid and the X-ray showed no enlargement of the thymus. There was a huge tumor in the upper left quadrant with marked dilatation of the superficial veins. No blood was found in the

urine on repeated examinations. The Wassermann test was negative and several differential blood counts showed no abnormality. The X-ray examination showed no change in the bones of the skull and no enlargement of the thymus. Carbon dioxide gas was injected in the peritoneum and a diagnosis made of a large tumor in close relation to the upper pole of the left kidney. There was no evidence of lung metastasis.

Under ether anaesthesia an oblique incision was made into the peritoneal cavity, just below the left costal border, and the large tumor readily exposed.



FIG. 1.—Hypernephroma of the suprarenal.

There was no excess of peritoneal fluid and the uterus and ovaries were infantile. The descending colon and splenic flexure were displaced to the right and the posterior peritoneum spread over the tumor contained a large number of dilated vessels. The peritoneum was divided and the tumor quickly and easily enucleated, but not without rupture. The mass was very easily separated from the upper pole of the kidney and there was apparently no involvement of the kidney, which was normal in size. The inner edge of the posterior peritoneum was sutured to the right edge of the anterior peritoneum and in this way the abdominal cavity was shut off. Two

rubber covered drains were inserted and the wound closed. The child was in good condition at the close of the operation, but the temperature began to rise and the next morning it had reached  $105^{\circ}$  and the respirations were 60. The child died rather suddenly about 20 hours after operation.

Specimen consisted of an encapsulated, rounded mass, weighing 720 gms. and measuring 13 cm. in diameter. Histological diagnosis.—*Hypernephroma*.

#### INDICATIONS FOR BRONCHOSCOPY

DR. CHEVALIER JACKSON said that he was often asked, in what class of cases of lung abscess he would advise bronchoscopy for treatment. In answer he could very truthfully say in no case whatever should bronchoscopy be used for treatment and thoracotomy delayed. In any case, however, in which for one reason or another the internist or surgeon feels that external

## INDICATIONS FOR BRONCHOSCOPY

surgery should be delayed it might be well to carry out bronchoscopic aspiration and possibly contribute to the diagnosis. The situation here is different from that which exists in foreign body suppuration in the lung. Foreign body suppuration in the lung has a tendency to get well. Diagnostically and pathologically it differs from post-pneumonic inflammation and suppuration. In the foreign body form there is a barrier built up ahead of the inflammatory process. In others there is no barrier and the suppuration gets in from underneath and proceeds in a different way from suppuration due to foreign body. For instance one of his foreign body cases, a boy was supposed to have a pin in his lung, the mother would not consent to operation and for eleven years he spit up pus. Tuberculosis was diagnosed and the patient kept in bed and outdoors for the most of the eleven years in California. He came to the speaker after being in bed continuously for six months during which time he had gained 15 pounds in weight which was supposed to negative any possibility of the contention of the mother being correct as to the foreign body. The bronchoscope was put down. A pin was located deep in the right lower lobe; the pin was removed through the bronchoscope and the boy got entirely and completely well. This is something one does not see in cases of post-pneumonic or post-influenza processes. There the patients do not recover promptly after bronchoscopy.

Bronchoscopy can contribute in another and important way to the work of the surgeon. It can contribute just as the cystoscopic examination contributes to the work of the genito-urinary surgeon. The genito-urinary surgeon wants to know if pus is present in the urine coming from the bladder or kidney and if from the kidney he wants to know whether one or both and if one, which one. These are things for which he develops certain means of diagnosis. Then too there is the X-ray man. He can tell him something. When the cystoscopist and the X-ray man get together they can tell a good deal more. Just so the bronchoscopist can contribute to the work of the thoracic surgeon. For instance, a patient came to him badly exsanguinated from hemorrhage; had been bleeding off and on for two years; trouble dating from influenza four years before. Patient only twenty-eight years of age. On going down, the bronchoscope in the right lower lobe struck a deformity. This is one great characteristic of cancer of the lung and it was from this deformity that the blood came. A specimen taken from the tumor was reported to be adenocarcinoma. Had it come back negative one would have felt that it was malignant just the same because of the nodular tumor associated with the deformity. In regard to the treatment of lung suppuration.—Suppose when one goes down into the bronchus instead of finding this bronchus normal, one finds the middle lobe of the bronchus ulcerated, granulation tissue and pus streaming from the orifices. If one does not find it in the lower lobe and if the pus below is aspirated and does not recur, one can then tell the surgeon that the suppuration is in the middle lobe. If he decides to postpone operation one can take out the

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granulations and aspirate the pus as frequently as necessary with the bronchoscope. Just as the genito-urinary surgeon will set aside certain cases for cystoscopic treatment, just so there are certain cases which the thoracic surgeon will set aside for bronchoscopic treatment.

It is utter folly to hope to remove malignancy through the bronchoscope. But suppose the bronchoscope has been used six months earlier in the case, and given a definite diagnosis when the growth was limited to the interior of the right lower lobe, the surgeon would have had a chance to amputate the lung. When a patient is twenty-eight years of age and suffering from such a condition the patient wants a definite diagnosis. The bronchoscopist gets the specimens and the laboratory makes the diagnosis of adenocarcinoma. Thus is obtained definite information on which to proceed. One wants to be sure about the diagnosis before performing lobectomy. The bronchoscope may help in this. The time has come when the thoracic surgeon has as much need for the assistant familiar with the use of the bronchoscope as the genito-urinary surgeon has for the assistant familiar with the cystoscope.

### RADIUM IN PELVIC CARCINOMA

DR. JOHN G. CLARK said that he recently had made a very careful study of the follow-up from the standpoint of five-year cures in cancer of the uterus by the use of radium. In the study of this question one has to take into account the quantity of radium which has been used by the various investigators or applicators. He had one rule which is 100 mgms. for 24-hour application. Formerly he repeated this 2 or 3 times but from the further study of cases as he went on, he came to the conclusion that the impact was made at the first application, and accordingly since then he had sometimes applied it twice but practically never three times. In other words, if the radium does not control the growth on the first application one may hope that something further may occur on the second application but if this fails, never apply the third dose because this is just a supernumerary operation that may do more harm than good. If it does not do much good at the first application he may be skeptical of the future. At first there was the original controversy between abdominal hysterectomy and vaginal hysterectomy. He gave up the vaginal hysterectomy in favor of the abdominal and then finally went to the more radical abdominal operation.

The following tables were submitted:

#### (1) *Vaginal Operation*

Total of Cases .....	1205
Operability .....	654 - 58.1 per cent.
Primary mortality .....	192 - 9.35 per cent.
Of cases traced .....	29.67 per cent.
Of cases operated upon .....	17.75 per cent.
Of cases applying for treatment .....	9.62 per cent.



## RADIUM IN PELVIC CARCINOMA

### (2) *Carcinoma of the Cervix*

Total cases .....	5027
Operability .....	1720 - 24.31 per cent.
Mortality .....	1090 - 18.23 per cent.
Of cases traced .....	35.41 per cent.
Of cases operated upon .....	19.32 per cent.
Of cases applying for treatment .....	11.72 per cent.

The objection to the radical operation for carcinoma of the cervix is the high mortality.

The following tables are from the results reported by different men and form an interesting comparison.

#### (1) *Graves*

Total applying .....	189 cases
Operability .....	64 per cent.
No. of operations .....	119 cases
Primary mortality .....	5 per cent.
Five-year cures .....	34.2 per cent.

Radical operation for carcinoma of the cervix.

#### (2) *Peterson*

Total applying .....	380 cases
Operability .....	15.7 per cent.
No. of operations .....	60 cases
Primary mortality .....	26.6 per cent.
Five-year cures .....	40.9 per cent.

He was convinced that there is a wide range between what one man calls a radical operation and what other men call radical. In other words one sometimes starts in to do a radical operation, but does not do it although the chart states that he did. Here too is seen the wide range between two men as to what they consider operability. The only way to calculate statistics is from the standpoint of how many cases one has seen in the course of a year and at the end of five years how many of these are alive. All men vary; one day if one feels particularly peppy and looks at a case, he calls it operable; the next day if one is not so peppy and were to see the same case for the first time he would probably say it was not operable. Much depends on the way the individual feels.

#### (3) *Martzloff*

Total applying .....	387 cases
Operability .....	46 per cent.
No. of operations .....	178 cases
Primary mortality .....	14.2 per cent.
Five-year cures .....	26.6 per cent.

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These results are from the Johns Hopkins Hospital and are not from clinical studies alone but from the laboratory reports, so that they found there were some cases which ten years before were diagnosed as carcinoma but which today laboratory men would not consider such owing to the endometrial changes. One will notice from these charts the great range of operability and mortality statistics.

### (4) *Bailey and Healy*

Operability .....	27 per cent.
Border line cases .....	24 per cent.
Inoperable .....	14.5 per cent.
Recurrent inoperability .....	22 per cent.
All cases over five years.	

### (5) *Burnham (These statistics are not up to date)*

Operability .....	50 per cent.
Border line cases .....	24 per cent.
Inoperability .....	9 per cent.
Recurrent inoperability .....	11 per cent.

### (6) *University Hospital*

No. of cases .....	144
Operability (22) .....	27.2 per cent.
Inoperability (118) .....	6.7 per cent.
Recurrent inoperability (4 cases 1 recovery) ..	25 per cent.
Total five-year cures .....	10.4 per cent.

Radical operation had 8 per cent. mortality. He thinks the cases were all in the operability class. The best results he had ever received before using radium was 33 per cent. with 8 per cent. mortality. My own experience could not be compared with that of anyone else, but he thought the present radium statistics are better than his previous statistics. The radium treatment means two or three days in the hospital at the most, with immediate return to the home for the patient, and the whole picture is better. So even if one does not get any better results with radium than with the radical operation, one has at least helped the surgeon, has done a service to the patient from the economic standpoint. Of the large number treated there will be a considerable number who never bleed again and in whom the discharge is reduced to a minimum, a certain number who are relieved of pain. As time goes on and he studies his cases, he finds few operable cases, and most of these come at the end of the day when his operable judgment is not its best. He has not entirely given up the operation but had only done three or four cases a year and these mostly on tradition. The results he had shown are for his first five years of radium treatment and he believed those for the next five will be better. He practically never applies radium now without anaesthesia, he now thoroughly packs the vaginal wall as he found that he could not apply the lead plates without packing and not have

## COMPOUND FRACTURE-DISLOCATION OF ELBOW

here and there a crevice for them to get through with the possibility of burning a hole in the rectum or vagina. The first series had a large percentage of fistulae. Doctor Keene informs me that since 1920 we have had no fistula cases following radium application and he attributes this to the more careful application with anaesthesia and the packing back of the antero-posterior wall away from the radium.

## COMPOUND FRACTURE-DISLOCATION OF ELBOW

DR. JOHN H. JOPSON presented a man, fifty-six years of age who was admitted to the Presbyterian Hospital, November 28, 1923, having been struck by auto. Sustained lacerated wounds of scalp and eye-brow, an impacted fracture of the stump of an old amputation of right arm below the shoulder, and a fracture-dislocation of the left elbow, compounded; also abdominal contusions. X-ray showed an impacted fracture of the surgical neck of the right humerus stump, a fracture of the left olecranon process, the detached fragment pulled upward and backward, with an anterior dislocation of the shaft of the ulna, and the head of the radius, both riding forward and upward on the anterior surface of the condyles. There was a wound the size of a lead pencil on the posterior surface of the elbow, communicating with the fracture of the ulna. There was considerable swelling of the elbow. The patient complained of pain especially in right shoulder and abdomen. Attempts were made by Doctor Pfeiffer and Doctor Jopson to maintain reduction by traction from elbow outward, using 8 pounds weight, in combination with an internal angular splint. The fracture of the humeral stump was impacted, and required no special dressing. An X-ray made on December 3, showed little change in position. The wound in elbow was granulating. On December 4, 1923, reduction was effected under anaesthesia and the arm re-dressed on a right angle splint. The following day traction was added over upper surface of forearm. On December 12, straight extension was applied to overcome the recurring displacement of both bones, but without effect. The wound was not healed sufficiently at this time to permit of the open operation which was seen to be needed. On December 21, 23 days after the injury, the wound being healed, an open operation was performed. Two incisions were necessary. A straight posterior one over the elbow, in the median line, and a Kocher incision over the outer condyle and head of radius. The head of the radius was excised, and a portion of the upper end (articular surface) of ulna removed, before the detached olecranon process could be approximated to the shaft of the ulna, where it was fixed by two silver wires, passed at right angles through drill holes in the bone fragments. This maintained reduction, and a plaster case was applied with elbow flexion nearly at right angle. The wounds healed cleanly, and the case was removed on January 12, 1924, the X-ray having shown perfect reduction of dislocation and apposition of fragments. A removable plaster dressing was applied, and light massage and assisted active movements begun. The fixation of the joint at this date was almost complete. All dressings were removed after 5 weeks, and massage, hot packs and general physio-therapy measures begun. The man still in hospital. Movement improving. Supination and pronation incomplete, about 50 per cent. of normal motion. Flexion and extension still limited, but improving. About 60° of motion 12 weeks after operation. Arm is strong; can push and pull with strength. This is important, as this man is a switchman, and has but his left arm to depend upon to earn his living.

SEPARATION OF LOWER EPIPHYSIS OF THE FEMUR WITH FRACTURE  
OF THE SHAFT OF THE TIBIA

DOCTOR JOPSON presented a girl, aged seven years, who was admitted to the Presbyterian Hospital, June 28, 1923. On the preceding day she jumped down from a stone wall on which she had been sitting. A large stone was displaced as she jumped, and struck her on the posterior surface of the left lower extremity. On admission the left knee and leg were swollen. At least one-half inch shortening was present. There was an anterior displacement of the knee, due to forward and upward displacement of the lower femoral epiphysis with overriding, and a transverse fracture of the tibia, middle third, with forward displacement of the upper fragment. The problem presented was to effect and maintain reduction of the femoral epiphysis, as well as of the fragments of the broken tibia. Doctor Speese and Doctor Jopson had treated supracondyloid fractures of the femur with tongs extension in the last few years, and with satisfactory results. They had used skeletal traction in a number of cases of fracture of other types which were formerly treated by open operation. Doctor Jopson applied tongs to the epiphysis in this case and used extension in conjunction with the Thomas splint, balanced suspension and self-contained traction over the end of the splint, using 8 pounds weight. The knee-joint was flexed, and the leg encased in moulded plaster splints, and supported on a Cabot splint attached to the Thomas splint. Three days later X-ray showed reduction of overriding of the epiphysis, but  $20^{\circ}$  forward angulation remained. This was overcome by bending the Thomas splint above the knee, changing the direction of pull on the epiphysis. The tongs were removed after 9 days, and the fixation maintained by bandaging the thigh to splint, and continuing suspension. X-ray showed good position on this date. One week later the leg and thigh were encased in plaster, with the knee slightly bent. The case was split before discharge, on July 23, to her home in the country, with instructions to remove it at the end of 8 weeks, after which guarded use of the limb was to be begun. The results in this case were very satisfactory. Various methods of effecting and maintaining reduction are advised in displacement of this epiphysis, and most authorities emphasize the danger of displacement of the epiphysis after apparent satisfactory reduction. This is the only case in which he had used tongs traction in children, but in the Bellevue Hospital series reported by Burdick and Siris, (*ANNALS OF SURGERY*, June, 1923) calipers were applied in 5 cases of fractured femur in a total of 268 cases, and credit given the method as a means of avoiding open operation.

DR. MORRIS K. SMITH (New York) said that one reason why cases of separation of the lower femoral epiphysis are regarded with dread is, that the type of accident causing them is likely to be so severe that the associated injuries add to the seriousness of the case. MacAusland has collected thirty-six cases of which ten came to amputation and four died.

It was his own impression of separated epiphysis that union sets in more promptly than after diaphyseal fractures, so that a delay in coming to reduction may increase the difficulties disproportionately.

He had recently had a case of separation of the lower femoral epiphysis in a boy of twelve years of age who, while climbing a fence, fell with his shoe caught in a picket. The lower end of the shaft was displaced posteriorly

## SEPARATION OF LOWER EPIPHYSIS OF THE FEMUR

into the popliteal space as in Doctor Jopson's case. He was fortunate in seeing him within two hours of the injury. Under anaesthesia it was possible to reduce the displacement by extension, but by flexing the knee, traction and pushing the upper fragment forward, reduction was satisfactorily accomplished. The leg was maintained in flexion with adhesive plaster strapping for two weeks. The boy left the hospital on crutches at the end of three weeks, and was walking without crutches within two months.

It is too early to know whether shortening will eventuate, but the study of end results in separated epiphyses leads one to emphasize that the prognosis should be guarded.

DR. JOHN GERSTER (New York) reported the case of a girl of eight with a transverse supracondylar fracture of the femur at the epiphysis, easily reduced by manipulation in extreme flexion and maintained in this position; the child was walking perfectly at the end of four weeks.

A case similar to that of the elbow fracture reported by Doctor Jopson was in a powerful young man injured in a motor-cycle accident. A slightly compounded fracture of the olecranon whose line of fracture running transversely through distal half of articular surface of ulna, permitted lower fragment of ulna and radius to move together freely up anterior surface of humerus, was immediately operated through a lateral longitudinal curved incision one-half inch to outer side of ulna, the subcutaneous aspect of bone being exposed and a four-screw Lane plate applied. Passive motion from the first day. Lane plate removed under local anaesthesia four weeks later. Several years later (in 1917) he was passed by Draft-board as he had no physical disability. In addition to his elbow injury he had a simple oblique fracture of the upper third of femur (treated by nail extension for three weeks and then plated at open operation) and a compound comminuted fracture of both bones of the leg—lower third—(plaster case). All fractures were on same side of body.

DR. JOHN H. GIBBON (Philadelphia) thought that in all elbow fractures, too much attention was paid to exact co-adaptation of fragments and the fixation of the joint and urged the importance of early passive and active movements. As the preservation of flexion is of the greatest importance, he thought that even neglect of the olecranon fracture might be advisable in certain cases, in order to preserve flexion and keep up motion; even where the olecranon is fixed by open operation to the shaft, the arm should be dressed in acute flexion and early motion practiced. Unless there is wide separation of the olecranon from the shaft, one can count upon a fibrous union with a good functional result. Nature does a great deal by shortening muscles to make up for a permanent separation of the fragments, if there is a good fibrous union. One often sees wide separation of the patella, following fractures, with a fibrous union and a good function. Early and constant movement he considered one of the most important parts of the treatment.

In regard to the separation of the lower femoral epiphysis, he also urged the fixation of the leg in acute flexion and early motion. He advised against



the use of case or splint in these cases and recommended that acute flexion be maintained by a figure-of-eight passed about the ankle and thigh.

DOCTOR JOPSON in closing, said that in the case of compound fracture dislocation of the elbow, he agreed that immediate operation would probably be preferable. Should he encounter another such case he would operate immediately, if conditions permitted. He did not agree with Doctor Gibbon when he advises not to operate in such cases. The wide separation of the fragments would greatly diminish the strength of the arm, and an operation

would certainly be required eventually. He recalled one such case in which Doctor Pool operated for non-union of the olecranon, and secured a good result, but had to do a plastic lengthening of the triceps tendon. The same thing sometimes happens in fractures of the patella. He had operated on two cases in which a failure of bony union followed non-operative treatment of the fracture, in both of which the patients were crippled before operation and were completely cured after operation.

#### EXCISION OF A BRANCHIAL FISTULA

DR. ASTLEY P. C. ASHHURST showed a man, nineteen years of age, on whom he had operated at the Episcopal Hospital, December 19, 1923. The patient complained of a more or less constant semi-purulent discharge from a minute opening on his neck, situated at the anterior border of the right sternomastoid muscle, about 3 cm. above the clavicle (Fig. 1). The



FIG. 1.—Branchial fistula, discharging at lower end of anterior border of right sternomastoid muscle. Note ++ on borders of picture, as guides to site of orifice.

patient pointed out that a cord, about the size of a pencil, could be felt running upward from this point for a few centimetres, when it seemed either to stop or to become lost in the deeper tissues. The patient stated that he had had this discharging sinus, to his knowledge, since the age of five years; and that it was a constant annoyance, staining his underwear and making him uncomfortable. Whenever he swallowed, this sinus was retraced a little upward. He presented no other abnormalities. A diagnosis of branchial fistula was made, and Dr. W. R. Watson, otolaryngologist to the hospital was

## EXCISION OF A BRANCHIAL FISTULA

asked to examine the pharynx: this he reported as normal; the lad's tonsils had already been removed.

*Operation.*—December 19, 1923.—Ether was administered by intrapharyngeal tubes. The fistula was injected with melted paraffin, its orifice being barely large enough to admit the end of a fine cannula. An incision about 10 cm. long was made in the line of the skin folds, excising an island of skin including the fistulous opening. On dissection, the tract, which was about the size of the omohyoid muscle, was found to extend upward along the anterior border of the sterno-mastoid muscle as far as the upper border of the thyroid cartilage, where it became deeper. To expose it better, a second incision, 7 cm. long was made in the same direction as the first, below the border of the mandible. The portion of the fistulous tract already dissected was then delivered through this upper incision, and traced further. It passed between the external and internal carotid arteries, and was followed to its



FIG. 2.—Patient eleven days after operation—inconspicuous scars.



FIG. 3.—Specimen of branchial fistula, after hardening and shrinking in formalin.

origin in the wall of the pharynx just below the digastric muscle. Every time the patient swallowed the tract was drawn up toward the pharynx, and its attachment to the pharynx was seen to be funnel-shaped. The end of the tract was ligated, the tract cut off, and the stump swabbed with carbolic acid, and then buried by a purse-string suture of chromic catgut, as the appendix stump is treated. There was considerable difficulty in placing the purse-string suture, owing to the depth of the wound and the comparative thinness of the pharyngeal wall. During the dissection the fistulous tract broke almost in two at one point, while rather strong traction was being made on it; pressure on it then caused an extremely fine pencil of paraffin or inspissated pus to exude from its lumen. This pencil of paraffin was about the size of an ordinary cambric needle—one-half to three-quarters of a millimetre in diameter. As the upper and lower neck wounds communicated with each other by an opening only just large enough to thrust the fistulous tract through, it was thought safer to drain each wound separately, with a strip of rubber tissue.

The wounds were closed in layers with chromic catgut, and with lock stitch of equisetene for the skin.

The drains were removed after 48 hours, and the incisions healed promptly, leaving inappreciable scars (Fig. 2). On the third and fourth days after operation

there was some swelling and pain in the right tonsillar fossa. Dr. W. R. Watson examined the throat about two weeks after operation and found no evidence of any abnormality. For some weeks after operation the patient complained of pain in the throat at the site of the purse-string suture, but this gradually disappeared, and at present, three months after operation, he is free from symptoms. As the entire tract was removed, there is no reason to fear a recurrence.

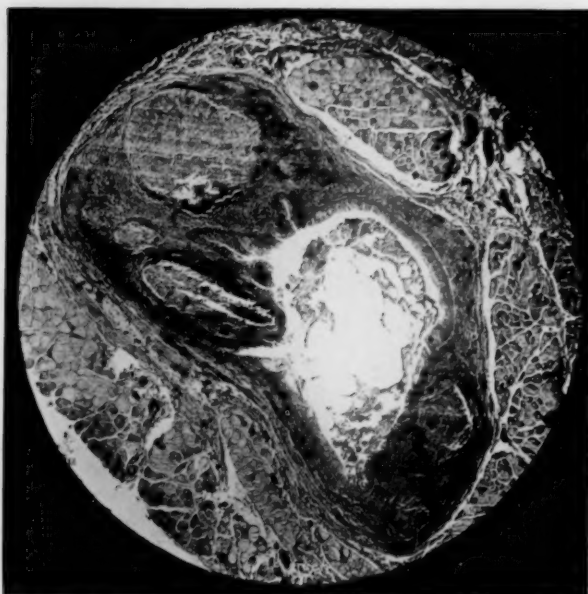


FIG. 4.—Microphotograph of cross-section of branchial fistula in its upper third; showing the lumen lined by stratified columnar ciliated epithelium; lymphoid tissue in the walls; muscle tissue at the periphery.

The fistula, after hardening in formalin measured about 10 cm. in length (Fig. 3).

Microscopical examination was made by Dr. C. Y. White of sections cut from the specimen at four different levels. These showed a tube lined by stratified ciliated columnar epithelium, except in the section from the extreme end near the pharynx, which showed no lumen. The section nearest the skin showed no lymphoid tissue in the walls of the tract; that next above showed a little lymphoid tissue; the third showed much lymphoid tissue (Fig. 4); while the fourth, at the pharyngeal wall showed only muscle.

#### INSULIN IN SURGERY

DR. JOHN SPEESE (Philadelphia) said that the introduction of insulin has so revolutionized the treatment of diabetes and the results of its use are so well known that it is unnecessary to dwell upon the medical aspect of the question. The interest now is more particularly in ascertaining to what extent insulin can be used in surgery or in surgical cases complicated by diabetes, the latter constituting a class regarded as critical and in which surgical intervention has not always been followed by the most encouraging results.

Diabetic acidosis is controlled so readily by insulin that its use in other conditions, giving rise to acidosis, naturally followed. Insulin may have its greatest use, from the surgical point of view, in the treatment of various forms of acidosis, whether pre-operative or post-operative. It is a well known fact that if glucose is given by rectum, subcutaneously or intravenously there is a gradual disappearance of the acidosis encountered in a variety of conditions. Since insulin causes rapid utilization of glucose in the body it follows that its injection ought to clear up the effect of acidosis

## INSULIN IN SURGERY

more rapidly than when glucose alone is given. While the number of reports of patients so treated is comparatively small, the results are encouraging and indicate that the intravenous administration of glucose controlled by insulin makes safe for operation many cases of starvation acidosis and controls the acidosis seen in post-operative conditions. Pre-operative acidosis constitutes a grave complication of the condition for which surgical intervention may be necessary, and may be so severe that valuable time is lost in the treatment by glucose injections alone. Response to its use with insulin is so prompt that many desperate cases may be saved by this more rapid and more specific method of treatment.

In diabetes complicated by infection, insulin by rapidly controlling the diabetes raises the patient's resistance and increases his chance to combat the infection. In such cases active measures against the infection should be instituted early and valuable time not lost in an attempt to control the diabetes with insulin. In several cases of severe wide-spreading infection, insulin had little or no effect upon the diabetic acidosis until the infected area was excised.

In rapidly spreading gangrene of the moist variety with acidosis associated with diabetes, and probably increased by absorption from the gangrenous part, immediate amputation followed by insulin therapy has given better results than preliminary insulin injections followed by amputation. In the dry variety of gangrene, on the other hand, with less infection and less acidosis, preliminary treatment with insulin can be used with less danger of delay. Several cases of incipient or threatened gangrene in diabetes seemed to be prevented by insulin.

There is no doubt that diabetic patients undergoing operations for chronic surgical conditions can be rendered good surgical risks by a combination of dietetic treatment and insulin. Many cases apparently hopeless from acidosis and coma first have been treated with insulin after which the surgical lesion has been attended to successfully. The effect of dietary measures alone is not to be minimized for such regulation accomplished much heretofore. Insulin, however, assures a more rapid response in the treatment preparatory to operation.

He had had the opportunity of administering insulin in the post-operative treatment of one case of acute hemorrhagic pancreatitis complicated with calculous cholecystitis. Drainage of the gall-bladder and pancreas was performed, on the following day there was a pronounced increase in blood sugar, acidosis and impending coma. The use of insulin with active carbohydrate administration was responsible for the rapid disappearance of the acidosis and hyperglycemia. Later a normal blood sugar ratio was controlled and maintained by regulation of the diet and insulin injections. In conclusion he emphasized the necessity of careful medical supervision of these cases, both in the administration of insulin and in the regulation of the diet.

## NEW YORK SURGICAL SOCIETY

### ACUTE MECHANICAL INTESTINAL OBSTRUCTION TREATED BY HIGH TEMPORARY JEJUNOSTOMY

DR. WALTER ESTELL LEE (Philadelphia) read a paper with the above title for which see page 45.

DR. SEWARD ERDMAN (New York) believed that the high enterostomy which has been brought to the notice of the surgical world in recent years, is of the utmost importance in the treatment of ileus whether of mechanical origin or of the paralytic type which latter so often accompanies peritonitis. During the past three years he had had the opportunity of following this method of treatment as applied to appropriate cases on the Second Surgical Division of the New York Hospital in the service of Dr. E. H. Pool. Including cases in private practice, they had now a series of 35 jejunostomies, two of which were for the sole purpose of feeding. There remain 33 cases performed for the relief of ileus associated with peritonitis and the mortality was 51 per cent. All of these were desperate cases where the expectant mortality is extremely high in the presence of spreading or general septic peritonitis and they feel that 49 per cent. recoveries represents the benefit of high intestinal drainage in such cases, and that some lives were thus saved.

The advantage of early intervention is shown by the fact that in those cases operated upon and the jejunostomy performed within 48 hours of the onset of ileus symptoms, the mortality was only 35 per cent., whereas in cases where jejunostomy was delayed to the third day or later, the mortality rose to 63 per cent. The 33 cases include fifteen jejunostomies for general peritonitis from acute appendicitis; eight for peritonitis of pelvic origin; five for peritonitis from traumatic rupture of the intestine; three for strangulated ventral hernia, and two for unusual forms of pyloric obstruction. One of the pyloric cases developed high obstruction immediately following the resection of the jejunal ulcer at the site of a previous gastro-enterostomy. In this case they performed early a jejunostomy for feeding and at the same time a Witzel gastrostomy for drainage of the stomach.

The relief of vomiting was immediate and jejunostomy feeding was very effective. After three days both tubes were withdrawn and the wounds healed promptly with relief of all symptoms.

DOCTOR VAN BEUREN (New York) reported statistics at the Presbyterian Hospital from Dr. Beverly Smith of 59 cases of enterostomy done in the ten years preceding 1916. Of these there were 47 done for acute intestinal obstruction. About 45 per cent. of these patients had peritonitis more or less diffuse. The mortality in cases of enterostomy (high or low) in cases of acute ileus was 90 per cent. Now the general mortality in cases of acute ileus was something like 50 per cent. It was, therefore, very surprising to find that the enterostomy which is expected to increase the chances of survival actually appeared to have increased the mortality. On going over the cases in some detail it was discovered that in very many of them the enterostomy was not performed until a relatively late moment in the course of the disease and that death occurred within a few hours after the enterostomy.



## FECAL FISTULA

He was finally forced to the conclusion that enterostomy had been used in most of these cases rather as a last resort than as prophylactic or curative procedure. It ought to be emphasized again that enterostomy is a procedure which should be employed early. Other things being equal, the severity of the symptoms in proportion to the length of time they have existed should give one a lead as to whether to operate or not and, if operation is performed, whether an enterostomy should be included in the operation or not. The more severe the symptoms in proportion to the time that they have existed the more urgent the need for operation and the more probable the need for enterostomy. The procedure outlined by Doctor Lee is the one which had been in use at the Presbyterian Hospital for the last two years.

## FECAL FISTULA

DR. JOHN B. DEEVER read a paper with the above title for which see page 56.

DR. WALTON MARTIN (New York) said that there are two important things to consider: whether the fistula is due to the stump of the appendix or due to erosion or sloughing of the bowel wall. Doctor Deever had mentioned the rigid drainage tube and thought it might be a factor in producing necrosis. The speaker had not had occasion to see many cases due to this in the last few years. Another type is that where fecal concretions escape from the appendix opening and remain at the bottom of the sac.

# TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

*Stated Meeting Held March 26, 1924*

The President DR. EUGENE H. POOL, in the Chair

## SUBTOTAL GASTRECTOMY FOR RECURRENT GASTRIC ULCER

DR. RICHARD LEWISOHN presented a woman, sixty-five years old, who had been previously operated upon by another surgeon at Mount Sinai Hospital in November, 1922. At the time of her first admission she gave the following history: She had suffered from gastric distress for twenty years. During the last year she had very severe pains. X-ray examination showed a penetrating ulcer of the stomach with about  $1/5$  residue after 6 hours. A pre-operative transfusion of 500 c.c. of citrated blood was given. Operation revealed a penetrating gastric ulcer, adherent to the pancreas. The adhesions were freed and the ulcer excised with knife and cautery. The defect was closed in layers. No gastro-enterostomy. The symptoms recurred a few weeks after the operation. X-ray examination revealed a recurrent penetration with more than  $1/3$  residue after 6 hours. Ewald test-meal: free Hcl. 45, total acidity 55. She was sent to the dispensary for further observation and treatment.

The patient was re-admitted to Mount Sinai Hospital in October, 1923. Her suffering had been so intense during the last few months that a secondary operation was indicated. Re-laparotomy revealed a large crater ulcer (size of a quarter) on the posterior wall of the stomach with dense adhesions to the pancreas and posterior parietes. The ulcer extended almost to the level of the cardia. The stomach showed moderate hour-glass formation.

A subtotal gastrectomy was performed. The base of the ulcer was left adherent to the pancreas. Closure of the duodenum in three layers. Button gastro-enterostomy between stump of the stomach and jejunum. A citrate transfusion (750 c.c.) was given after the operation. The patient made an uneventful recovery. The button was passed about seven weeks after the operation.

The specimen shows that about  $4/5$  of the stomach was removed. The patient states that she is free from pain since the second operation. X-ray examination shows that the stoma functions perfectly.

## PARTIAL GASTRECTOMY FOR DUODENAL AND GASTRO-JEJUNAL ULCER

DOCTOR LEWISOHN presented a man, forty-one years old, who had undergone two previous operations on the stomach. These operations were performed at Mount Sinai Hospital by another surgeon.

The first operation which dated six years back, consisted of a suture gastro-enterostomy without exclusion for duodenal ulcer with pyloric obstruction.

He was perfectly well for over five years. Seven weeks before his second admission to the hospital (1922) pains and vomiting recurred. X-ray ex-

## PARTIAL GASTRECTOMY FOR GASTRO-JEJUNAL ULCER

amination revealed an irregular, tender stoma, one-half residue after three hours and a large residue after nine hours. Diagnosis: gastro-jejunal ulcer. Five days after his admission he had a very profuse hæmatemesis which required a transfusion of 500 c.c. of citrated blood.

Exploratory laparotomy (January, 1923), showed a dilated stomach, which was imbedded in so many adhesions that it could not be delivered. An indurated mass (gastro-jejunal ulcer) was palpated at the stoma. A small hard mass, about 1 cm. in diameter, was felt at the pylorus, apparently with a crater in its centre. The pylorus was densely adherent to the gall-bladder. During the attempt to free these adhesions the pylorus was entered. The opening was closed in layers, after a small piece had been excised for pathological examination (inflammatory tissue). The patient's condition was so poor that it was impossible to attempt any radical procedure. The abdomen was closed. Immediately following the operation a transfusion of 500 c.c. of citrated blood was given. After this transfusion the hæmoglobin was 36 per cent.

The patient vomited large amounts of dark blood following the operation. The hæmoglobin had fallen to 18 per cent. on the seventh day post-operative. Another citrated transfusion brought the hæmoglobin back to 35 per cent. The patient's condition improved gradually and he was transferred to the medical service where irrigations with colloidal iron (Epstein treatment) were given. He was discharged about two months after the second operation in good condition.

Patient was admitted to Doctor Berg's service at Mount Sinai Hospital in September, 1923. He had recurrence of his old symptoms for one week. He vomited large amounts of blood on the day of admission. An immediate transfusion of citrated blood brought his hæmoglobin from 20 per cent. to 30 per cent. Another blood transfusion (Unger method) was given a few hours before the operation. In spite of a fairly high hæmoglobin (48 per cent.) the patient looked extremely pale and was a very bad operative risk. However, the only possible way of saving this man's life seemed to be a radical operation which would definitely prevent recurrence of the hæmatemesis.

The operation (September 15, 1923) revealed a large gastro-jejunal ulcer and a duodenal ulcer between the 1st and 2nd portions of the duodenum. Extensive adhesions between the stomach and the abdominal wall were freed, the colon was separated from the gastro-jejunal induration. The gastro-enterostomy was discontinued and the jejunal opening closed. At this point the anesthetist reported that the pulse was imperceptible. An intravenous saline infusion was given. On account of the patient's precarious condition separation of the duodenal ulcer from the pancreas was contraindicated. The stomach was resected just beyond the pylorus at its distal end and beyond to the old stoma at its proximal end (Finsterer operation). A large crater ulcer could be seen in the duodenum after the stomach had been cut across. Both duodenum and stomach were closed in layers and a button gastro-enterostomy was performed. The patient made an uneventful recovery. The button was passed a few weeks after the operation. X-ray examination shows perfect function of the stoma. Ewald test-meal shows: free Hcl. 5, total acidity 30. It is interesting to note that the duodenal ulcer had persisted in spite of the fact that the patient had the benefit of a gastro-enterostomy for seven years. The patient has gained twenty pounds since this operation.

DOCTOR LEWISOHN stated that in discussing cases in which primary radical procedures had been employed in order to establish a permanent cure, the objection was often raised that more conservative operative measures might have cured the patient. In these two patients conservative procedures had been tried without avail. If at the time of the primary operation a partial gastrectomy had been performed, these patients would have been definitely cured by one, instead of by two and three operations.

DR. JOHN F. CONNORS said that he was at a loss to know what to do for gastric ulcers. He did not believe that gastro-enterostomy is a cure for gastric ulcers and he firmly believed there is only one indication for it and that is pyloric obstruction. He realized that in the hands of most men, himself included, they cannot hope to obtain the low mortality obtained at Mt. Sinai Hospital until they have had a wider experience with this operation. He felt like one in the dark and hoped some day that a better understanding will come as a result of the partial gastrectomy on one side and a gastro-enterostomy on the other and all shall see the light as to truly what is the best operation in these cases.

#### BONE GRAFT FOR WIDE SEPARATION OF SYMPHYSIS PUBIS

DR. FREDERIC W. BANCROFT presented a woman who had suffered a fractured pelvis, September 18, 1920. When admitted she was in shock, complaining of pain in the stomach and legs following an automobile accident. She vomited several times following the accident. She complained also of pain in the lumbo-sacral region, left ankle, and in the pelvis, her scalp was lacerated.

Physical examination showed tenderness over the iliac crests; large ecchymosis of the right labium, contusion and hæmatoma of the left ankle, contusion of the back in the lumbo-sacral region. X-ray September 20, 1920, showed fracture and dislocation of the pubis and fracture of the ascending ramus of the right ischium. X-ray September 28, 1920, fracture of the posterior os calcis (left); separation of pubic bones and fracture of the right ramus. She recovered being left with distinct waddle, walking with great difficulty due to a permanent separation of the symphysis pubis.

November 1, 1921, Doctor Bancroft operated for the purpose of making a bone graft transplantation to relieve the separation of the symphysis. Pfannenstiel incision over pubis.

1. Scar tissue dissected away. Both ends of the symphysis were isolated. They were separated about  $2\frac{1}{2}$  inches. There was considerable atrophy and both ends were surrounded by bursæ. Scar tissue between the fragments was separated free. Fragments were thoroughly isolated and they were beveled off on the anterior surface, leaving a free bleeding surface of cancellous bone.

2. Semi-elliptical incision over left tibia. A piece of bone including its periosteum 1 inch by  $3\frac{1}{4}$  inches was removed from the anterior surface. This extended down to the medullary canal which in this particular tibia was about 0.5 cm. from the anterior surface. The muscles were sutured over the tibia and the skin and subcutaneous tissue closed with silkworm and silk.

Gloves and instruments used in this procedure were then discarded. Piece removed was split longitudinally so that it consisted of two pieces, was then fixed to the symphysis bridging the defect, and held in place by chromic sutures, inserted through drill holes in the transplant and symphysis

#### FRACTURE-DISLOCATION OF THE CERVICAL SPINE

Fat and connective tissue were united around the transplant as well as possible and the wound closed with silkworm gut and silk. The pelvis was immobilized as far as possible by a mole-skin plaster and plaster-of-Paris girdle extending from about a little above the umbilicus to below the femoral trochanters. Gas and ether. Duration of operation, one hour and fifty-three minutes. Condition good.

September 12, 1922, she was readmitted on account of a complete proidentia of the uterus with rectocele and cystocele—triangular ligament almost completely gone. The old graft in the pubis seems slightly movable at one end. Levator ani muscles retracted and much atrophied. Moderate discharge. Patient walked with a distinct "waddle gait." A distinct separation could be felt by manual examination between the two pubic bones.

September 20, 1922, Doctor Bancroft submitted her to vaginal hysterectomy and perineorrhaphy.

This case was presented because the X-rays show the persistence of the bone graft two and one-half years following operation. While there has been separation at one junction to the symphysis, this is so fixed with fibrous tissue that there is practically no free motion, and the patient is now able to walk without the waddling gait, which originally tended to interfere with walking. Also it is interesting to note that the wide separation of the symphysis probably caused a tear in the pelvic fascia. As a result of this a complete prolapse occurred.

#### LACERATED FLEXOR TENDONS, MEDIAN AND ULNAR NERVES

DR. FREDERIC W. BANCROFT presented a man sixty-four years of age who came to the hospital on December 8, 1922 suffering from laceration of tendons of wrist (left) with laceration of the ulnar and median nerves. Patient was walking down stairs and slipped, falling through a window glass. He threw his arm up to save himself and was cut across the wrist. Patient was conscious throughout accident. There was loss of function of all the fingers, no flexor-profundus or flexor sublimis function. There was loss of sensation over the distribution of the ulnar and median nerves.

On the following day Doctor Bancroft enlarged upwards at the ulnar border the incision which lay diagonally across the wrist on the ventral surface. The sublimis and profundus tendons had been cut. These were isolated and identified as far as possible. The median nerve was dissected up, isolated and sutured by three stay sutures through the neurilemma and then a fine continuous suture. The ulnar nerve was repaired in a similar manner. The profundus and sublimis tendons were then repaired as accurately as possible, but it was felt that possibly two tendons were not sutured correctly, but as the patient was an old man and the operative procedure had already lasted one and one-half hours, it was considered inadvisable to prolong it any further. The palmaris longus tendon was also sutured. The anterior annular ligament was closed with chromic and the skin with silk. The hand was put up in acute flexion.

Following the operation the patient had trophic ulcers at the tips of his fingers. He has been treated with baking and massage. At the present time he has no loss of sensation in the hand and motion at the wrist is normal. There is some atrophy of the interossei and some slight limitation of flexion.

#### FRACTURE-DISLOCATION OF THE CERVICAL SPINE

DR. ALFRED S. TAYLOR presented a man, twenty-seven years of age who had had recurrent dislocations of left shoulder and both patellæ. On



February 23, 1920, while wrestling he fell to the floor powerless; with pain in neck, especially on movement.

February 28, when examined, both upper extremities were partly paralyzed, and showed hypæsthesia in the musculospiral distribution. No loss of power in lower extremities, sphincters, or trunk. The only sensory disturbance (except above) was that below dorsal ii; both hot and cold were called hot. Reflexes: absent in upper extremities, abdomen and cremaster muscles; knee jerks slightly exaggerated; abdominal reflexes normal; no Babinski. Rapidly exhaustible ankle clonus on left side.

Flexion of the neck and rotation of the head to either side, whether active or passive, caused pain. Marked tenderness to pressure over the lower cervical spine both anterior and posterior, and deformity posteriorly.

Radiograph: showed fracture-dislocation of cervical v on cervical vi.

March 3, 1920 (eight days after injury) reduction was accomplished, without anæsthesia, by the method described below. Immediate relief of pains and discomforts followed.

A plaster-of-Paris jacket was applied. Radiographs two days later showed good condition. After two weeks a reinforced leather collar and breast-plate replaced the plaster jacket and he returned home.

March 23, due to misunderstanding he had removed the leather support several times. A radiograph showed partial recurrence.

March 26, a second reduction with plaster jacket fixation. A couple of weeks later a steel spinal brace with jury-mast to extend the head and neck was applied.

June 19, 1920, Radiograph showed a slight recurrence.

June 24, under local anæsthesia, open reduction was attempted but was only partially successful. Heavy silk sutures around the spinous processes were used to retain the best obtainable reduction.

At intervals radiographs were taken to show if bony union were occurring between cervical v and cervical vi. In March, 1921, union was sufficient to allow removal of brace.

There has been perfect recovery of function with solid union of cervical v and cervical vi.

DOCTOR TAYLOR presented a second case, a woman thirty-five years of age who on October 25, 1922, in an automobile accident, landed on her head and neck. Immediate total loss of function followed in trunk, sphincters and lower extremities. Partial loss in upper extremities. Very painful spasmodic contractions of the neck muscles. Twelve hours after accident, a slight return of certain reflexes and sensations below the lesion led Doctors Kennedy, Pool and himself to believe that the cord had not been completely crushed by the fracture-dislocation which had obviously occurred and was probably situated between cervical v and cervical vi.

Stereo-radiographs showed extreme forward dislocation of cervical v on cervical vi with some crushing of the bodies on the left side.

October 27, reduction under ether was accomplished. Radiograph immediately after, showed perfect alignment. A plaster jacket was applied to maintain extension and reduction.

The painful muscle spasms ceased at once. There has been a gradual return of function below the level of the lesion, somewhat irregular in distribution. Sphincteric control returned after a few weeks. At present the right upper and lower extremities move freely and with power. The left upper extremity still shows spasticity in the flexors and extensors of the fingers, but improvement is still occurring. Sensation is nearly absent in the right lower extremity, and is nearly normal in the left lower. She gets

## SPLENECTOMY FOR SPLENIC ANÆMIA

about with slight assistance, can write, and attends to her duties as an executive.

February 29, 1924, sixteen months after the reduction. Solid bony union was found to have occurred between cervical v and cervical vi. It had probably occurred sooner but no radiographs had been taken for several months.

DOCTOR TAYLOR called attention to the occurrence of neck dislocation in a patient suffering recurrent dislocations in shoulder and patellæ after injuries, showing poor reparative power.

Gradual absorption of the intervertebral disc, especially its anterior portion, with some erosion of the vertebral bodies, and this in spite of the extension apparatus. Slow development of bony union between the damaged vertebræ, (about one year in each case) showing the necessity of prolonged use of support. He thought a modified application of the same method might be useful in fractures and dislocations in other portions of the spine.

DR. EUGENE H. POOL said that he remembered this case very well. Soon after the patient was admitted to the hospital she showed symmetrical bilateral sensory and motor paralysis from area of the fifth and sixth cervical segment downward. He had never seen a case with such findings where the paralysis cleared up at all. The X-ray indicated such extensive displacement that it was thought that the cord must be completely destroyed at the level of dislocation. The reduction had been done in the most well-planned, deliberate and successful manner.

DR. ROYAL WHITMAN said he had recently seen a patient after complete recovery from a fracture and dislocation of the third cervical vertebra accompanied by paralysis. In this instance the displacement, which had resisted traction, had been easily reduced by direct pressure of the finger in the pharynx.

### SPLENECTOMY FOR SPLENIC ANÆMIA: CONTINUED HÆMATEMESIS DUE TO THROMBOSIS OF SPLENIC VEIN

DR. EUGENE H. POOL presented a man who in February, 1917, when he was nineteen years of age, complained of vomiting of blood and swelling of abdomen. He vomited a large amount of blood three times and was brought to hospital in an ambulance.

At twelve years of age he had a similar attack. At that time, there was a period of malaise for a week, and then he began to vomit blood. At that time, he vomited about two quarts, he thinks. Also a mass was noted in his left hypochondrium. Was ill in Mt. Sinai Hospital for five weeks. After leaving the hospital he got his strength back pretty quickly. Three months ago he vomited several ounces of blood.

On admission in 1917, there was on inspiration a projection of a definite mass in the left upper quadrant of the abdomen. The lower pole extends to the level of the umbilicus and inner margin within an inch of the midline. It moves with respiration. On palpation, this mass is firm and presents a notch on its mesial border. Liver edge not made out.

Blood Counts.—Counts made every two days showed increasing anemia.

Date	Hgb. %	WBC	Polys. %	Lymph. %	Trans.	Eos. %	RBC
Feb. 20th	55	8000	74	24	0	1	
March 2nd	27	6800	69	22	7	2	2,600,000

Date	Anisocytosis	Poikilocytosis	Normoblast per 100 WBC
Feb. 20th	1 plus	1 plus	..
Mar. 2nd	1 plus	1 plus	1

Wassermann blood, negative.

Fragility test on red blood cells, March 3, 1917. Hæmolysis begins at 58 per cent. Hæmolysis complete at 38 per cent. Vital stain: 2.2 per cent. Basophilis stripping. Blood coagulation time, 8 minutes Duke coagulometer.

Bleeding time increased (not recorded). Stools showed blood five times. Operation, March 3, 1917 by Doctor Pool. 1. Transfusion by Lindemann method. 2. Four hundred c.c. of blood transfused. Spleen found to be enlarged; very firmly adherent; covered by omentum. The omentum was drawn mesially so as to expose the spleen. It was found to have a thick capsule and was very firmly adherent to the parietal wall at the outer and upper part. The adhesions were cut and torn with considerable bleeding until the spleen was mobilized, two towels being placed against the bleeding areas to control hemorrhage. A stomach clamp with rubber tubes was placed across the pedicle. The pedicle was ligated piece-meal and the spleen excised. The raw areas and bleeding points were then approximated by continuous stitch of catgut. Wound closed without drainage. The specimen was found to consist of a moderately enlarged, slightly deformed spleen, weighing 610 grams and measuring  $18\frac{1}{2} \times 11\frac{1}{2} \times 5$  cm. The sections of the spleen showed the microscopic features of a marked grade of chronic interstitial inflammation. The trabeculæ are increased in number and in thickness. The Malpighian bodies are of varying size, some being quite small, others of normal size or larger; a few of the Malpighian bodies show a central proliferation of endothelial cells. The pulp of the organ presents everywhere considerable spaces among the meshes of the coarse reticulum in which are some blood cells and nucleated cells.

The patient when seen at intervals thereafter was generally well, except for some distress after meals and a great deal of gas. His bowels moved naturally every day.

June 21, 1923 he was admitted to St. Luke's Hospital on account of epigastric distress with belching of gas and nausea with bloody vomitus. no evidence of ulcer of stomach or duodenum. Transfusion of blood 500 c.c. was done. He left the hospital greatly improved, but was readmitted two months later, having redeveloped a severe secondary anemia, for which a renewed transfusion of 500 c.c. was done. Following his discharge from the hospital he had another hemorrhage from the stomach, suffered from indigestion and was finally re-admitted to the New York Hospital on November 26, 1923 complaining of bloody vomitus and blood in stools, with epigastric pain and some elevation of temperature.

December 3, 1923, an exploratory laparotomy was done by Doctor Pool. through a right rectus incision. The liver looked practically normal, consistency and color showing nothing unusual. A piece was removed for examination. The hand passed into the splenic region revealed a number of adhesions which indented stomach somewhat but no ulcer or neoplasm could be recognized on palpation. The lesser curvature and remainder of stomach showed nothing abnormal. The duodenum, however, presented a peculiar white color; also some induration but this ran very distinctly into a hard nodular thickening between duodenum and liver. The true nature of this could not be determined. The hand was passed down into the abdomen and nothing abnormal felt elsewhere. The stippling and thickening of the upper duodenal wall suggested the possibility of ulcer, therefore a transverse incision was made. Careful examination of the mucous membrane of duodenum through this orifice failed to reveal an ulcer. A piece from the margin of this was removed to determine whether there was duodenitis. The nodular, indurated tissue above the duodenum seemed to extend behind the lesser curvature; the whole corresponding somewhat to the situation of

## SACRO-COCCYGEAL CHORDOMA

pancreas. A piece was removed for microscopic examination. The opening in the duodenum was now closed with two layers of chromic catgut.

The reporter thought that the tissue changes were inflammatory. The extension of the induration back of the stomach and along pancreas suggests the course of the splenic vein. It may well be that a retrograded thrombosis of the splenic vein occurred with some infection and inflammatory changes around this. This, however, seems less probable on account of the long interval since the operation of splenectomy. As to the pancreatitis the induration seemed to be rather above than in the pancreas.

Microscopic sections of liver show the liver cells with a clear cytoplasm (the normal appearance which is seen when the liver is fixed immediately after removal from a living subject). There is no increase in connective tissue. Section of mucosa from duodenum show Brunners glands covered by a thin atrophic mucosa. Section of thickened area on duodenal wall shows adipose tissue divided up with bands of mature fibrous connective tissue. Several large blood-vessels are cut in transverse section and show thickening of wall and partial obliteration with what is apparently an organized canalized thrombus.

### BLOOD COUNT

Date	Hgb. %	WBC	Polys. %	Lymph. %	Mono. %	Trans. %	Eos. %	RBC
Nov. 26	60	7550	64	26	6	2	2	3,550,000
Dec. 20	50	10200	66					3,912,000

## SACRO-COCCYGEAL CHORDOMA

DR. EUGENE H. POOL presented a woman whose previous history is given in *ANNALS OF SURGERY*, 1922, vol. lxxvi, p. 123. The case was then presented before this Society as a rarity. It is now shown two and one-half years after operation to record the late result. According to N. D. C. Lewis (*Arch of Int. Medicine*, 1921, vol. xxviii, p. 434) these tumors rarely give rise to metastases, but infiltrate widely and have proved 100 per cent. fatal. An incomplete operation was performed, removing soft tumor tissue through an opening in dorsum of sacrum. Radium was subsequently applied through this opening at the General Memorial Hospital. She was recently admitted for observation: complete fluoroscopic and physical examination failed to reveal any metastases. The sacrum was opened dorsally and the interior of the mass was found bony hard. There was no soft tumor tissue. Specimens removed failed to reveal tumor microscopically. Cystoscopic and rectal examinations were negative, except the original bony projection in the hollow of sacrum. As far as can be determined there is no extension of the growth more than two and one-half years since the palliative operation. It is of interest as offering encouragement for radium treatment in similar cases. This type of tumor seems peculiarly favorable to radium treatment, since it is generally stated that it does not metastasize and the tumor gives the impression of low vitality, consisting of a slowly growing mass of syncytial tissue.

The following notes of the treatment given at the Memorial Hospital, complete the record of the case.

May 6, 1921, X-ray treatment 15 minutes to sacrum, May 13, 1921, 15 minutes to pubis. July 3, 1921, tubes of radium emanation with silver filtration were placed in the sacral wound, 456 mc. hours being given. August 1, 1921, tumor of sacrum showed marked regression. Patient has complained of some low abdominal pain during past two weeks. August 9, 1921, discharged—improved. August 23, 1921, on rectal examination the tumor in sacrum seemed much smaller and more nodular than it was several



months ago. The external lesion in anal crease appears to be healing. September 13, 1921, sacral wound nearly healed. Still a sinus at its bottom leading apparently directly into sacrum. Rectal examination same. X-ray treatment, October 4, 1921, 15 minutes to sacrum; October 11, 1921, 15 minutes to pubis. Examination in X-ray Department, December 28, 1921, patient complains of severe pains in pelvis. To receive further X-ray treatment. X-ray treatment, January 6, 1922, 15 minutes to pelvis posteriorly over sacrum. March 29, 1922 patient had severe pain and has difficulty in defecation. April 14, 1922, she was given a 20 minute treatment over pelvis with X-ray.

October 29, 1923, the superficial nodes are not particularly marked in any group and not suggestive of secondary growths. Fluoroscopic examination of the general skeleton shows no areas that are suggestive of new growths.

DR. JOHN F. ERDMANN asked if there had been any suspicion of this chordoma being a variety of sarcoma. He had had three cases, two in which the tumor had been regarded as sarcoma and the third unknown. The first one he removed some years ago and the patient lived for one and one-half years before expiring. He did not know what became of the second case. The third was a young man also, (all the patients were males,) who was operated on one and one-half years ago and radium was used and he is now in excellent condition. He gained thirty pounds in weight after the operation.

DOCTOR POOL replied that the pathologists reported the tumor was a typical chordoma with characteristic syncytial tissue. There was nothing to suggest it was a sarcoma.

#### HÆMOLYTIC JAUNDICE IN A CHILD OF FOUR YEARS

DR. A. O. WHIPPLE presented a child aged four years, who three weeks before admission, developed a sore throat with a little fever every night. This lasted for two weeks. One week before admission she vomited yellow fluid with a little blood. Her mother noticed that the skin and eyes were yellow and urine was dark. The child was a seven months baby, which only weighed two and one-half pounds at birth. Always small and underweight. The father had had attacks of jaundice every year since he was six years old. Was diagnosed acquired hæmolytic jaundice one year ago and spleen removed by Doctor Whipple.

The patient was an underdeveloped girl of four years, pale, skin yellow, scleræ yellow. Tonsils large and cryptic. Liver palpable two fingers breadth below costal margin. Spleen sharp, hard, non-tender edge palpable two fingers breadth below costal margin.

Laboratory findings: White blood cells, 13,400; polymorphonuclears, 63 per cent.; red blood cells, 4,320,000. Fragility test was strong through .45 and partial through .55—slight at .60 as opposed to control which stopped at .45. Urine urobilin, 720-800. Dilution units. Stool 4500 dilution units of urobilin as opposed to normal 450. Wassermann negative cholesterol. Red blood cells 5 per cent. reticulated.

While in the hospital the jaundice cleared up except for slight suggestion of yellow in the scleræ. The liver and spleen have remained unchanged. At conference it was decided to wait and follow the case and operate only if patient began showing increased destruction of red blood corpuscles.

Final diagnosis, congenital hæmolytic jaundice. Discharged, home improved.



## SUBPHRENIC ABSCESS AND ACCUMULATIONS OF FLUID

DR. JOHN F. ERDMANN said that he had during the past week had two cases of hæmolytic jaundice, brothers, one a boy of  $4\frac{2}{12}$  years and the other  $6\frac{1}{2}$  years of age. He had removed their spleens. They were the children of a mother who had her spleen removed for familial jaundice. The pathologist reported they were absolutely hæmolytic spleens from the blood picture. He had another case of a child of thirteen who was doing very well. He considered one was justified in going ahead and removing the spleen with the evidence presented by these blood changes.

## SUBPHRENIC ABSCESS AND ACCUMULATIONS OF FLUID

DR. JOHN DOUGLAS read a paper with the above title for which see vol. lxxix, page 845.

DR. FRANK S. MATHEWS said that Doctor Douglas' paper would emphasize the fact that the diagnosis of subphrenic abscess in its early days is not always found easy even by competent physicians and surgeons. Most of the cases presented have come to operation after the abscess has reached considerable size. Doctor Mathews' last case of subphrenic abscess was operated on through a gall-bladder incision under the impression that the case was one of acute gall-bladder disease. The abscess had extended over the surface of the liver and involved the fundus of the gall-bladder. It was probably secondary to a duodenal ulcer. It is his impression that gall-bladder disease, though not infrequently associated with liver infections, is a surprisingly infrequent cause of subphrenic abscess.

Doctor Douglas has reported a case of the speaker which was sent to the hospital as an empyema. Two things which cast doubt upon this diagnosis were, first, that the pus removed by aspiration had had an odor suggesting the colon bacillus, and, second, that there was a fulness and tenderness under the origin of the right rectus muscle. The diagnosis was cleared up by an X-ray which showed a bubble of gas under the diaphragm.

DR. ALLEN O. WHIPPLE gave a brief summary of the cases of subphrenic abscess at the Presbyterian Hospital during the past ten years. There were twenty in all. Four followed acute appendicitis, 5 acute cholecystitis, 2 followed ulcer, 3 were associated with pneumococcus bacteræmia, 1 was associated with empyema, 1 followed lung abscess, 2 followed perinephritic abscess, and 2 followed pelvic disease. Bacterial examination showed streptococcus in 5, staphylococcus in 2, pneumococcus in 2, mixed culture in 5, only 14 out of the 20 being cultured. There were 6 deaths, one of the appendicitis cases, one gall-bladder case, 2 ulcer cases, one pneumonia case, and one of the cases of pelvic disease.

A point, in addition to the importance of the X-ray as an aid in the therapy of this complication, which Doctor Whipple wished to emphasize was the importance of not making too early an attempt to drain these collections. The tendency, with an early diagnosis, is to explore as soon as the high diaphragm is detected. This is a mistake. The fluid should be allowed to

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become localized and needless trauma can thus be avoided as illustrated in a number of cases of this series that had become well localized after drainage and gave an exceedingly good result.

DOCTOR DOUGLAS, in closing the discussion, said that in his paper his main point was to emphasize that there had been a tendency in nearly all these cases to misinterpret the physical signs over the base of the lung as a chest lesion, and not to give due consideration to the history and physical signs which pointed to a pathological condition within the abdomen. He also called attention to the importance of the X-ray finding of air and a fluid level below a high and fixed diaphragm, and the necessity of making the X-ray examination with the patient in a position which will allow the air to rise to the highest point.

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